SIXTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1913-1914

PRINTED BY ORDER OF THE LEGISLATURE

QUEBEC

1914

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To the Honourable J. E. Caron, M. P.P.,

Minister of Agriculture,

Quebec.

Sir:—

I have the honour to present herewith the Sixth Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous diseases, containing proceedings of the winter meeting of the Society which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 27th of March, 1914.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,
Secretary-Treasurer.

Ottawa.
1914.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

OFFICERS FOR 1913-1914.

President—Professor W. Lochhead, Macdonald College.
Vice-President—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, P. Q.
Secretary-Treasurer—J. M. Swaine, Assistant Entomologist for Forest Insects, Department of Agriculture, Ottawa.
Curator and Librarian—P. I. Bryce, Assistant in Biology, Macdonald College.
Directors—Rev. Dr. Thos. Fyles, Ottawa.
Rev. Father Leopold, La Trappe.
Rev. Brother Victorin, Longueuil.
A. F. Winn, Esq., Montreal.
Prof. L. S. Klinck, Macdonald College.
Rev. Abbé Huard, Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Dr. Hamilton, Macdonald College.
Auditors—E. M. Duporte, Macdonald College.
Dr. Hamilton, Macdonald College.
Delegate to the Royal Society of Canada—Prof. Lochhead, Macdonald College.
Delegates to the Ontario Entomological Society—Mr. Chapais, St. Denis, Que.; Mr. Winn, Montreal.

MEMBERS OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

Adams, Prof. John . . . . . Dept. of Agr., Ottawa
Arkell, H. S. . . . . Dept. of Agr., Ottawa
Blair, W. Saxby . . . . . Kentville, N. S.
Bates, F. W. . . . . Regina, Sask.
Beaulieu, G. . . . . Dept. of Agr., Ottawa
Benjamin, Rev. Bro. . . . . La Trappe, Que.
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Buck, F. E. . . . . Dept, of Agr., Ottawa
Bunting, T. G. . . . . Macdonald College
Campbell, Rev. Dr. Robt. . . . . 68 St. Famille St., Montreal
Chagnon, George . . . . . M. L. H. & P. Co., Montreal
Chapais, J. C. . . . . St.Denis-en-bas, Que.
Chrystal, R. N. . . . . Dept. of Agr., Ottawa
Cloutier, H. . . . . La Trappe, Que.
Cowan, P. R. . . . . Macdonald College
Cutler, G. H. . . . . Saskatoon, Sask.
Dalaire, O. C. . . . . St. Hyacinthe, Que.
Dash, J. S. . . . . Dept. of Agric., Barbados, W. I.
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Drayton, F. L. . . . . Macdonald College

Dreher, W. C. . . . . Dept. of Agr., Ottawa
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Duporte, E. M. . . . . Macdonald College
Dupuis, Auguste . . . . . Village des Aulnaies, Que.
Durling, V. B. . . . . Macdonald College.
Eastham, J. W. . . . . Vernon, B. C.
Edouard, Rev. Father . . . . . La Trappe, Que.
Emilien, Rev. Father . . . . . La Trappe, Que.
Fiske, H. J. M. . . . . Macdonald College
Flewelling, D. B. . . . . Fredericton, N. B.
Fraser, W. P. . . . . Macdonald College
Fyles, Rev. Dr. Thos. W. . . . . 368 Frank St., Ottawa
Gibson, Arthur . . . . . Dept. of Agr., Ottawa
Grignon, Dr. W. . . . . Ste-Adèle, Que.
Gussow, H. T. . . . . Dept. of Agr., Ottawa
Hall, Landon . . . . . Cowansville, Que.
Hamilton, Dr. D. W. . . . . Macdonald College
Hammond, H. S. . . . . Macdonald College
Harrison, Dr. F. C. . . . . Macdonald College
Hewitt, Dr. C. G. . . . . Ottawa
Honoré, Rev. Father . . . . . La Trappe, Que.
Huard, Rev. Abbé . . . . . Laval University, Que.
Husk, R. E. . . . . Macdonald College
Jack, Norman E. . . . . Châteauguay Basin, Que.
Jenkins, M. H. . . . . Ottawa, Ont.
Klinck, L. S. . . . . Macdonald College
Leopold, Rev. Father . . . . . La Trappe, Que.
Liguori, Rev. Brother . . . . . La Trappe, Que.
Lloyd, F. E. . . . . McGill University, Montreal
Lyman, Henry H. . . . . 74 McTavish St., Montreal
Lochhead, W. . . . . Macdonald College
MacClement, Dr. W. T. . . . . Queen's University, Kingston, Ontario
MacFarlane, J. N. R. . . . . Macdonald College
McCormick, J. H. . . . . Macdonald College
McLennan, A. H. . . . . Macdonald College
McOuat, J. E. . . . . Macdonald College
Moore, G. A. . . . . Montreal
Nagant, H. . . . . Quebec
Newman, C. P. . . . . Lachine Locks, Que.
Raymond, A. . . . . La Trappe, Que.
Reid, Peter . . . . . Châteauguay Basin, Qut.
Reid, B. T. . . . . Macdonald College
Richardson, B. . . . . Macdonald College
Robinson, J. M. . . . . Kentville, N. S.
Roy, H. B. . . . . Macdonald College
Sadler, W. . . . . Macdonald College
Schafheitlin, A. O. . . . . Macdonald College
Simard, J. . . . . Dept. Agr., Quebec, Que.
Straight, E. M. . . . . So. Portland, Me.

Summerby, R. . . . . Macdonald College
Swaine, J. M. . . . . Dept. of Agr., Ottawa
Tourchot, A. L. . . . . St. Hyacinthe, Que.
Vanderleck, J. . . . . Macdonald College
Victorin, Rev. Bro. . . . . Longueuil, Que.
Winn, A. F. . . . . 62 Springfield Ave., Westmount

HONORARY MEMBER:

James W. Robertson, Esq., LL.D., C.M.G.

FINANCIAL STATEMENT

of the

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES.

1913.

RECEIPTS.

Brought forward from last year	$140.75
Provincial Government Cheque	250.00
Interest on Deposit to Dec. 31, 1913	4.86
	$395.01

DISBURSEMENTS.

Members' Expenses to Winter Meeting	$ 10.00
Expenses of Delegate to the Meeting of the Royal Society of Canada	5.00
Postage	5.00
Secretary's Stipend	50.00
Cost of Publishing the English Edition of the Fifth Report, "La Tribune", Sherbrooke, Que.	19.00
	89.00
Balance, cash on hand, March 29th, 1914	306.01
	$395.01

J. M. SWAINE,
Secretary-Treasurer,
Wm. LOCHHEAD,
President.

Auditors:
W. P. FRASER,
P. I. BRYCE.

SIXTH ANNUAL REPORT

of the

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

Report of the Winter Meeting.

The Sixth Annual Meeting of the Quebec Society for the Protection of Plants, was held at Macdonald College, on March 27th, 1914.

The opening business meeting was called to order by the President, Professor Lochhead, at 2 p.m. There were present:—

Professor Lochhead, Macdonald College.
Professor Lloyd, McGill University.
Father Leopold, La Trappe, Que.
A. Gibson, Ottawa.
J. C. Chapais, St. Denis, Que.
A. F. Winn, Montreal.
Rev. Dr. Robt. Campbell, Montreal.
E. M. Duporte, Macdonald College.
P. I. Bryce, Macdonald College.
Dr. Hamilton, Macdonald College.
W. P. Fraser, Macdonald College.
H. J. M. Fiske, Macdonald College.
J. M. Swaine, Ottawa.

The minutes of the last business meeting were read and approved.

Letters of regret for inability to attend the meeting were read from Rev. Abbé Huard, Quebec; Rev. Dr. Fyles, Ottawa; Rev. Bro. Victorin, Longueuil; Dr. C. G. Hewitt and H. T. Gussow, of Ottawa.

The Report of the Treasurer was read and accepted.

The President read a communication from Rev. Brother Victorin, of Longueuil College, advocating the publication by the Society of a new Flora of the Province of Quebec. The subject was thoroughly discussed in an endeavour to find a practicable scheme for carrying out so considerable an undertaking. The need of a new Flora of Quebec in the French language was evident to all. There were several views presented in regard to the sort of book that should be published. Some were in favour of writing an entirely new Flora, having in view the many additions to the list of Plants and the numerous changes in Botanical nomenclature since the time of Provancher; while others considered it better to revise and extend Provancher's Flora. Professor Lochhead was in favour of a small school text with a Flora as an appendix. The matter was finally left in charge of a committee; Professor Lochhead, Prof. Lloyd, Father Leopold and Dr. Campbell.

The List of Insects of the Province of Quebec was next discussed. Mr. Winn stated that the list of the Diptera would probably be ready for publication before our next meeting.

It was passed by the meeting that fifty dollars be made available from the Society's funds for expenses in connection with the preparation of this List; and also that a like amount be made available towards the preparation of a List of the Fungi of Quebec Province.

It was arranged to hold a summer meeting of the Society as in previous years, the place of meeting to be announced later by the President.

The following officers were elected for the ensuing year:—

President—Professor Lochhead, Macdonald College.

Vice-President—M. Auguste Dupuis, Director of Fruit Experiment Station, Village des Aulnaies, P. Q.

Secretary-Treasurer—J. M. Swaine, Assistant Entomologist for Forest Insects, Ottawa.

Curator and Librarian—P. I. Bryce, Assistant in Biology, Macdonald College.

Directors—Rev. Dr. Thos. Fyles, Ottawa.
Rev. Father Leopold, La Trappe.
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Prof. L. S. Klinck, Macdonald College.
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Dr. Hamilton, Macdonald College.

Auditors—E. M. Duporte, Macdonald College.
Dr. Hamilton, Macdonald College.

Delegate to the Royal Society of Canada—Professor Lochhead, Macdonald College.

Delegates to the Ontario Entomological Society—
Mr. Chapais, St. Denis, Que.
Rev. Father Leopold, La Trappe, Que.

The general meeting was called to order in the lecture-room of the Biology Building, at 3 p.m., by the President, Professor Lochhead. In addition to the visiting and local members of the Society, a large number of students were present and took part in the discussions of the papers read.

Dr. Harrison welcomed the visiting members to Macdonald College, and discussed various topics of interest to the Society.

At the afternoon and evening sessions many excellent papers were read and discussed. These appear in full in the body of the Report.

Following is a list of the addresses and papers read at the meeting:—

Report as Delegate to the Ontario Entomological Society—J. C. Chapais, St. Denis-en-bas.

The White Cystopus of Crucifers—J. C. Chapais.

Necessity for the Publication of a Flora for the Province of Quebec—Rev. Bro. Victorin, Longueuil.

The Injurious Flea-beetles of Quebec—A. Gibson, Asst.-Ent., Ottawa.

Spraying Items and Notes—Rev. Father Leopold, La Trappe.

Insects of 1913—E. M. Duporte, Macdonald College.

Notes on Shade Tree Insects—J. M. Swaine, Asst. Ent., Ottawa.

Let us Instruct the Farmers—G. Beaulieu, Asst.-Ent., Ottawa.

President's Address, "Insects and Disease"—W. Lochhead, Macdonald College.

Some Important Storage Rots of Vegetables—W. P. Fraser, Macdonald College.

Foul Brood Disease in Bees—F. W. L. Sladen, Asst.-Ent., Ottawa.

Some Beneficial Hemiptera (Bugs)—P. I. Bryce, Macdonald College.

Injury and Abscission in Impatiens Sultani—Prof. Lloyd, McGill University.

REPORT OF THE COMMITTEE ON FLORA OF THE PROVINCE OF QUEBEC.

Your Committee has considered the recommendations of Bro. M. Victorin made in the paper read at the present meeting in response to the request of the President, and begs to make the following report.

Your committee, agrees with the view that a revision of Provancher's Flora is, for the reasons set forth by Bro. Victorin, impracticable and unadvisable. But your committee feels at the same time that the publication in the near fuure of a *Flore de Québec* of some sort is highly desirable. The feeling is also strongly held that an exhaustive flora of the province, with full illustrations, for which the time is perhaps not fully ripe, is less necessary than one in the French language which would be generally useful in the schools. The absence of a suitable general text-book of botany is also patent.

Your committee, therefore, recommends that there be prepared a more limited general *Flore de Québec,* of such scope that it can be used very generally in the schools and colleges, illustrated as far as feasible so as to increase its usableness; and that there be combined with it a brief general discussion of botanical principles especially as they bear upon agriculture, arranged in such form as to make the whole book especially useful to schools in the country.

And further that an editorial committee be appointed by the president to undertake the preparation and supervision of such a book, to report at the next annual meeting of this Society, and in the meantime to confer with the Provincial Government as to the possibilities for publication.

Your committee recommends that the co-operation of interested institutions and persons be sought in order to the more efficient carrying out of the above plan.

Committee:—Dr. R. CAMPBELL,
FATHER LEOPOLD,
FRANCIS E. LLOYD.

Quebec Society for the Protection of Plants,
Annual Meeting, March 26th, 1914.

THE SAW-FLIES OF THE PROVINCE OF QUEBEC.

A Correction.

In the *Fifth Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases,* on page twenty-eight, the first sentence, in the bottom paragraph, reads, "No less than eight named insects have been related by Cresson, in his *Synopsis of the Hymenoptera of America, North of Mexico,* to *Climbex americana.*

In this passage, *related* (as well as *Climbex*) is a printer's error. I wrote *relegated,* in the sense of *referred.* (*Relego, are, avi, atum;* to refer; to transfer).

The insects referred by Cresson to *America* were:—

"*Alba* Norton, Trans. Am. Ent. Soc., I, 42° (= *americana*).

Dahlbomii Gué.; Norton, ibid, 42° (= var. *americana*).

decemmaculata Leach; Norton, ibid, 42° (= var. *americana*).

Kirbyi Brullé, Hym. 672, pl. 48, fig. 6,° (=var. *americana*).
La Portei St. Farg.; Norton, Trans, Am. Ent. Soc., I, 41° (=var. *americana*)
luctifera Klug; Norton, ibid, 41,°° (=var. *americana*).
ulmi Peck; Norton, ibid, I, 41,°° (=var. *americana*).
Viardi St. Farg, Ann. Soc. Ent. Fr., II, 454,° (=var. *americana*).

(The symbol ° after the numbers 42, etc., in this note signifies *female,* except in *Kirbyi, La Portei* when it signifies *male,* and in *luctifera* and *ulmi* both male and female.—Ed.)

THOMAS W. FYLES.

Ottawa, March 23, 1914.

PRESIDENT'S ADDRESS.

By W. Lochhead, Macdonald College.

Gentlemen:—

This is the sixth time I have had the honour of welcoming you to our Annual Meeting and of presiding over your deliberations. Organized in June, 1908, by a small group of enthusiastic workers who saw the need for gathering and disseminating information relating to those insect and fungous enemies of plants of the Province of Quebec, that cause much loss every year, the Quebec Society for the Protection of Plants is, I believe, doing a most valuable work. With the help of the Provincial Department of Agriculture, the Society is enabled to meet at least once a year and to publish an Annual Report containing the many admirable papers read at the Annual Meeting. I am pleased to state that this Report has been well received, not only by fruit-growers and others in the province interested in the protection of plants, but also by scientific workers in other provinces and countries. The practical, popular treatment of the injurious enemies of plants meets with the approval of all who read the Reports.

It is a matter of regret, however, that there are so few active workers in the province to help the Society in its commendable endeavour. But this condition is not peculiar to our Society; it is the experience of nearly all Societies of a similar nature that a few members do most of the work. Our membership will in all probability remain small, but that is no reason why the influence of our Society will not continue to increase as the results of our labours become known through the Annual Reports and the investigations of its members.

We appreciate the kindly yet active interest taken in our work by the Scientific Staff of the Divisions of Entomology and Botany of the Department of Agriculture, Ottawa, by their presence at these annual meetings. Our problems are their problems, and by co-operative action greater success can be achieved than if we worked independently.

To the Fourth Annual Report, issued in 1912, was published as an appendix: "A Preliminary List of the Lepidoptera of Quebec", compiled mainly by Albert F. Winn, of Westmount. This valuable Report was commended highly by Entomologists everywhere. It was the intention of the Executive that other Lists relating to the remaining Orders of Insects would soon follow, but the labour of compilation, being arduous, has been slow. It is hoped, however, that a Preliminary List of the Diptera will be ready for publication in the forthcoming Report.

The Executive has also in mind similar Lists of the Fungi of Quebec, but as yet little progress has been made in this direction. Perhaps in another year we may have something definite to report.

Since our last meeting an important book relating to plant diseases has appeared, viz.: Dr. Stevens' "Fungi which Cause Plant Diseases". This work fills a long-felt want, inasmuch as it brings together into a compact volume a large amount of valuable information scattered through many foreign publications which are often unavailable to English-speaking students. With the aid of Stevens' book the student of fungi is now in a position to determine without much trouble the *genus* to which his specimen belongs.

INSECTS AND DISEASE

By W. Lochhead, Macdonald College.

Introduction.

Although this subject does not properly come under the scope of a Society for the Protection of Plants from Insects and Fungous Diseases, yet on an occasion of this kind when all the papers deal directly with the protection of plants I have taken the liberty of going a little afield and discussing the relationship of insects to disease in man, a matter of great and growing importance at the present time. As entomologists we are all interested in the habits of insects, whether they injure plants or animals, and experience shows that frequently the information gained by workers in one field is of great value to workers in the other. It is often impossible to keep departments strictly water-tight.

Disease-Carrying Insects.

During the last fifteen years important discoveries have been made regarding the transmission of certain diseases by certain insects such as the mosquitoes, house-flies, stable-flies, gad-flies, tsetse-flies, fleas, bed-bugs and ticks.

Brues and Sheppard divide the diseases that are carried by insects into three groups:—

Group A.—Characteristically insect-borne diseases;

Group B.—Often insect-borne diseases;

Group C.—Possibly insect-borne diseases.

Under Group A are included malarial fever, yellow fever, filariasis, sleeping sickness, typhus fever, bubonic plague, African tick-fever, Rocky Mountain spotted fever of man, and Nagana and Texas fever of horses and cattle.

Under Group B. are included typhoid fever, cholera, dysentery, diarrhoea, tuberculosis, septicaemia.

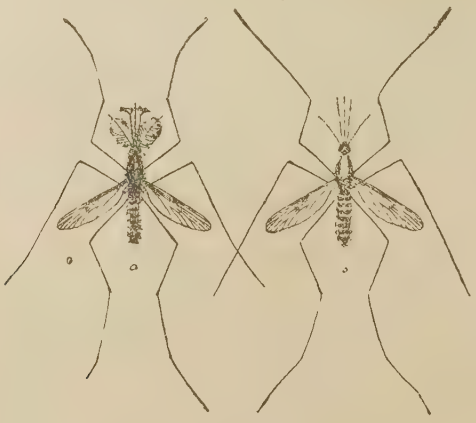
Under Group C. are included anthrax, rabies, pellagra, hookworm, beriberi, black water and relapsing fever of man; and equine infectious anaemia.

Anopheles Mosquito and Malaria.

Malarial fever and ague were common in Canada a generation ago, and our fathers vaguely attributed the disease to the presence of swamps whose numbers have fortunately been greatly reduced since by drainage.

The story of the discovery of the causal organism and of its life history in connection with the Anopheles mosquito is one of the interesting chapters in modern biological investigation. The organism belongs to the amoeboid Protozoa and was discovered by Laveran, a French army surgeon, in 1880. The part of

Anopheles as a second or intermediate host of the malarial organism was worked out later by Doctors Manson and Ross. (A full account of the discovery will be found in Kellogg's American Insects, and it is unnecessary for me here to describe the difficulties that were met and overcome).

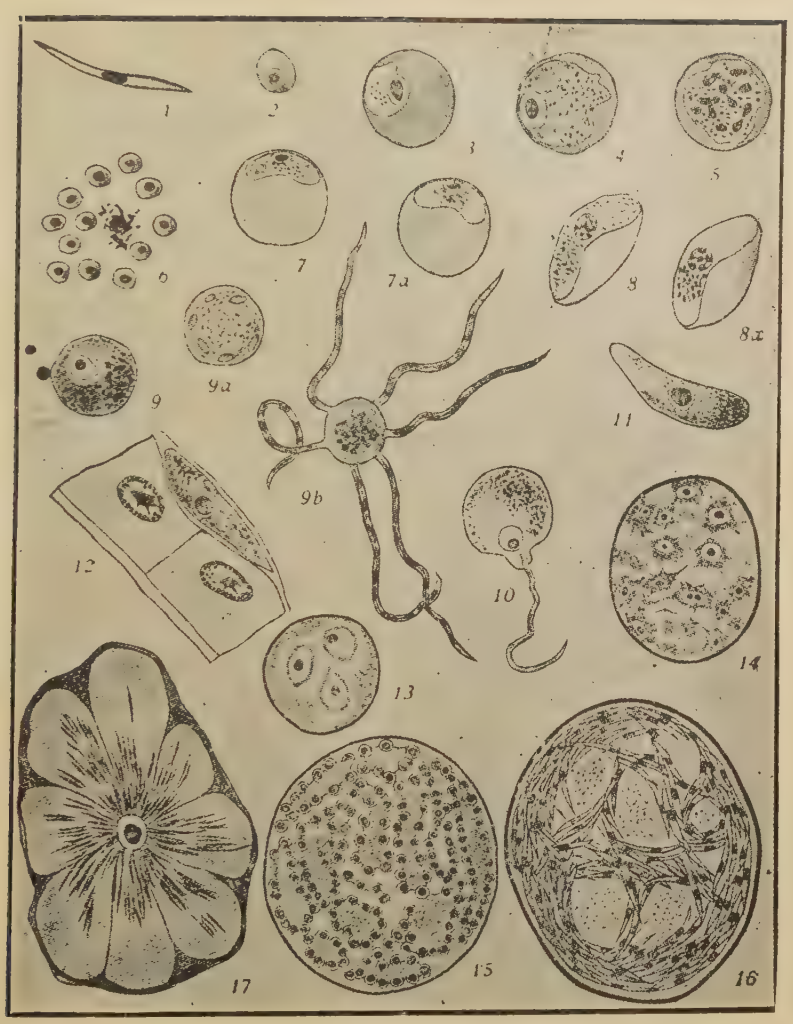


The malarial mosquito (*Anopheles*) : (*a*) male ; (*b*) female, enlarged.

The malarial plasmodium on gaining access to the human body lives within a red blood-corpuscle and thrives at the expense of the haemoglobin. A characteristic excretory product in affected cells is the black granules of *melanin*. In 48 hours the plasmodium reaches maturity and divides into many spores, termed *merozoites,* which are set free in the blood. These soon enter new blood-corpuscles and reach maturity in 48 hours as before. This production of spores coincides with the characteristic "chill" of ague, and is followed by a fever when the spores enter the blood-corpuscles. As a result of the destruction of the red blood-cells the patient becomes *anaemic*. Certain of these spores, however, make no attempt to enter new blood-corpuscles and may remain in the blood for an indefinite period. These are the *gametes*—the *micro* and *macro-gametes* — which, if taken into the stomach of an Anopheles mosquito, will, however, undergo further development. The male or micro-gamete produces a number of whip-like threads or *flagellae,* which are capable of uniting with the female or macro-gametes, producing *vermicules* or *ookinetes*. These penetrate into the wall of the stomach of the mosquito where they rest as *cysts,* forming little lumps on the outer surface. These cysts mature in about ten days and burst, liberating large numbers of *sporo*-blasts into the body cavity, whence they find their way to the salivary glands. When such an affected mosquito bites a human being these spores are injected into the blood and enter the red corpuscles. It will be seen, therefore, that ordinarily the Anopheles mosquito is the only agency for the transmission of malaria to man.

Stegomyia Mosquito and Yellow Fever.

The demonstration of the causal relation between Stegomyia mosquito and Yellow fever is another interesting story, and was worked out mainly by Major Walter Reed of the U. S. Army Medical Service in Cuba in 1900 and 1901. In



The Life Cycle of the Malaria Parasite:—1. The sporozoite or spore introduced by the mosquito bite into human blood; 2. The same free in the blood; 3-5. Changes which it undergoes within the red blood-cells; 6. Merozoites (spores) formed by division; 7-9. Development of a microgamete or female cell; 7a, 8a, 9a, 9b. Development of a microgamete or male cell; 10. Conjugation of the two sexual cells; 11. The resulting zygote; 12. Zygote that has entered the body of the mosquito as far as the stomach, lying at the base of two cells; 13-16. Zygote transformed into an oocyst filled with spores; 17. Cross-section of Salivary gland of mosquito, showing gland cells full of spores which have wandered in from cysts formed on the outside of stomach. (After Grassi and Leuckart).

1.—The yellow-fever mosquito (*Aedes calopus*) Stegomyia fasciata: Adult femaleMuch enlarged. (Howard)

his experimental camp Major Reed and his associates proved that yellow fever could not be transmitted by contact with yellow fever patients, but only by the bites of infected mosquitoes, except by the artificial injection of diseased blood. The causal organism has not yet been discovered on account of its being a filterable virus. It is known, however, that a 12-day incubation period is required in Stegomyia before its bite becomes infectious to a second person. Moreover, the mosquito can obtain infected blood from a patient during only the first three days of his disease.

Based on these facts, the control of yellow fever has become an easy matter. The patients are isolated as soon as the disease appears, and standing water in which Stegomyia might develop is treated with kerosene. Besides, all rooms in the building and adjacent buildings are fumigated, for the purpose of destroying living mosquitoes.

Culex Mosquito and Filariasis.—The tropical disease, *Filariasis,* is caused by a minute nematode worm, Filaria, which lives in the blood of man and certain species of Culex (C. fatigans). The worms escape from the mid-intestine of the mosquito into the muscular tissue where they grow for two or three weeks. They then migrate to other portions of the body and often collect at the base of the proboscis, whence they are carried into the human blood circulation. Sometimes the worms become three or four inches long and obstruct the lymphatic

canals, causing elephantiasis, characterized by enormous swellings of the legs, arms and other parts of the body.

House-fly and Typhoid Fever.

Much attention has been directed in recent years to the dangers of the house-fly (Musca domestica) and other flies as agents in the transmission of disease.

The common house-fly : (*a*) adult fly ; (*b*) maggot ; (*c*) puparium ; (*d*) details of feeler ; (*e*) end of body of maggot.

All Public Health Departments now take cognizance of the house-fly and issue warnings against its presence about the home. Epidemics of typhoid and cholera in many cities as well as the outbreaks during the Spanish-American war brought

The foot of a house-fly, showing pads, claws, and hair upon which disease germs are carried.

out the fact that the house-fly was largely responsible for the troubles. The habits of this insect are such as to make its presence dangerous. It breeds in

filth, and as an adult fly it feeds on all kinds of decaying and fecal matter, as well as the sweets and liquids of the dining table. Its feet and proboscis are admirably adapted for carrying those bacterial germs that cause typhoid fever, cholera, dysentery, diarrhoea, tuberculosis, etc. Moreover, it has been shown that typhoid bacilli swallowed by the house-fly when it feeds on and crawls over contaminated substances survive the passage of the alimentary canal, so that "fly-specks" may contain many active typhoid germs.

It has been shown also that several other species of flies that frequent houses may also convey typhoid bacilli. The "little house-fly". (Fanna *canicula ris*), the Latrine-fly (Fannia scalaris), the blow-fly (Calliphora erythrocephala), *Muscina stabulans,* the cluster-fly (Pollenia rudis), and the stable-fly (Stomoxys calcitrans) have all been found guilty and precautions should be taken to guard against their presence.

The charges proven against the house-fly as an active agent in disseminating not only typhoid fever but also cholera, dysentery and tuberculosis are overwhelming. This insect pest should therefore be banished from our midst. If we do not care for our own health we should at least protect the helpless children who are perhaps the greatest sufferers.

(For further particulars the excellent works of Doctors Hewitt and Howard should be consulted).

Stable-Fly and Infantile Paralysis.

The stable-fly (Stomoxys calcitrans), the horn-fly (Haematobia serrata), gad-flies (Tabanus and Chrysops), and the black-fly (Simulium) have both piercing and sucking beaks and are true blood-suckers. As such they are liable to introduce virus into the human blood.

Through the investigations of Doctors Brues, Rosenau and Sheppard of Massachusetts and of Doctors Anderson and Frost of Washington, published in 1912 and 1913, there is fairly conclusive evidence that infantile paralysis is mainly transmitted by the bites of the stable-fly. The reasons for suspecting the relationship are (Brues) :—

"1.—The blood-sucking habits of the adult fly suit it for the transfer of virus present in the blood.

"2.—The seasonal abundance of the fly is very closely correlated with the incidence of the disease, rising rapidly during the summer and reaching a maximum in July and August; then slowly declining in September and October.

"3.—The geographical distribution of the fly is, so far as can be ascertained, wider, or at least co-extensive with that of poliomyelitis (infantile paralysis).

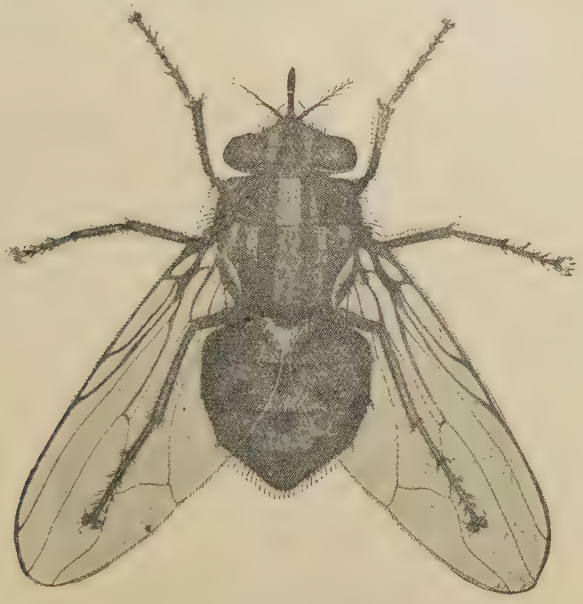
"4.—Stomoxys is distinctly more abundant under rural conditions than in cities and thickly populated areas.

"5.—While the disease spreads over districts quickly and in an erratic way it often appears to follow along lines of travel, and it is known that Stomoxys will often follow horses for long distances along highways.

"6.—In a surprisingly large number of cases it appeared that the children affected had been in the habit of frequenting places where Stomoxys is particularly abundant, i. e., about stables, barn-yards, etc."

The investigators referred to conducted experiments regarding the transmission of poliomyelitis from one monkey to another through the medium of Stomoxys. It was satisfactorily demonstrated that poliomyelitis could be transmitted in that way.

The causal organism has not yet been definitely isolated, although Doctors Flexner and Noguchi have recently obtained in cultures extremely minute bodies of variable size and appearance which they believe may be the causative organism.



The stable fly : Adult female as seen from above. Greatly enlarged. (Howard)

Tsetse-flies and Trypanosomiasis. — Tsetse-flies (Glossina spp.) are not native of America, but belong to tropical and sub-tropical Africa. They are blood-sucking flies, closely related to stable-flies, and in recent years have been shown to be causally related to severe diseases of both man and domesticated animals. Dr. Bruce made the important discovery that *Nagana,* a very fatal disease to horses, cattle, dogs and donkeys in South Africa, was produced by a *trypanosome* carried to the blood by the bites of tsetse-flies. These trypanosomes are flagellate protozoa, and when they occur in the blood of certain warm-blooded animals set up a disease called *trypanosomiasis.* They are carried from one host to another by certain invertebrates, such as mosquitoes, lice, fleas and especially by such blood-sucking flies as the tsetse-flies.

The Nagana disease is caused by *Trypanosoma brucei* and the tsetse-flies mostly concerned are *Glossina morsitans* and *G. pallidipes.*

In the Congo Basin of Central Africa the terrible "sleeping-sickness" disease carries off tens of thousands of natives every year. Doctors Forde and Dutton isolated the specific causal organism of this disease, which was named *Trypanosoma gambiense,* and Bruce and Navarro traced the organism to the bite of the tsetse-fly, *Glossina palpalis.* Folsom states: "In the first stage of the dis-

ease, marked by the appearance of trypanosomes in the blood, negroes show no symptoms as a rule, though whites are subject to fever. The symptoms may appear as early as four weeks after infection or as late as seven years.

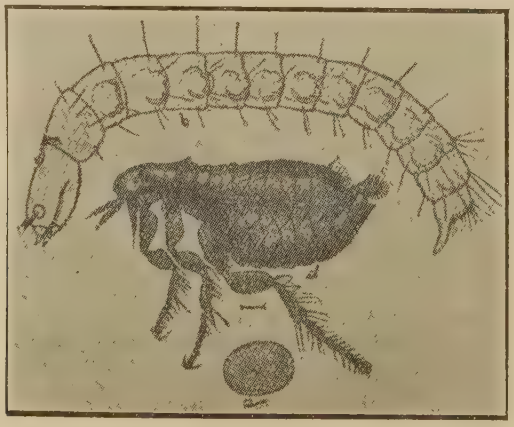
"In the second stage trypanosomes appear in the cerebro-spinal fluid and in large numbers in the glands, those of the neck, axillae and groins becoming enlarged. There is tremor of the tongue and hands, drowsiness, emaciation and mental degeneration. The drowsiness passes into periods of lethargy which become gradually stronger until the patient becomes comatose and dies. Some victims do not sleep excessively but are lethargic and profoundly indifferent to all going on around them."

Late investigations go to show "that *Glossina morsitans* may act as a host for a human trypanosome which is probably identical with *T. gambiense*". Probably also "that some of the vertebrates other than man may harbour *T. gambiense* and that there is a possibility of these things being transmitted to man" (Doane).

With regard to the development of *T. gambiense* in *Glossina palpalis* it is known that "two days after biting an infected animal the fly becomes incapable of infecting other animals and remains so for about 22 to 28 days, when it again becomes infective and may remain so for at least 96 days. During the infection period the salivary glands are found to be invaded with the type of the trypanosome that is found in the vertebrate blood" (Doane).

Rat Fleas and Plague.

Plague, known in three forms as bubonic, septicaemic and pneumonic, is caused by *Bacillus pestis* which attacks rats, mice, cats, dogs and other domestic animals. The disease is transmitted mainly by fleas, sometimes by bed-bugs, and



The cat and dog flea : (*a*) egg ; (*b*) larva of maggot ; (*c*) adult, much enlarged.

the wounds made by the bites allow entrance to plague bacilli. "Plague is primarily a disease of rats, an epidemic of plague in these animals having often been observed to precede as well as to accompany an epidemic among human beings."

The recent outbreak of pneumonic plague in Manchuria showed another phase of infection. This disease is not dependent on fleas for its transmission, but it could be traced to an outbreak of plague in the tarabagans or marmots, a kind of squirrel. Dr. Cantlie says that Plague may develop or appear in the following stages: (1) as a disease in animals; (2) Pestis minor conveyed by infected insects; (3) bubonic plague, sporadic cases, carried from animals to man by insects; (4) epidemic bubonic plague carried from man to man by insects; (5) pneumonic plague passing from man to man directly, or conveyed by insects. Dr. Kitasato is quoted as saying that the (Manchurian) pulmonary plague cannot spread through the air, the digestive tract is plague-proof, and that direct contact is necessary.

Rocky Mountain Spotted Fever Tick (Dermacentor Venustus) 1. An engorged female; 2. same male. (Year Book, U.S. Dept. Agr. 1910.

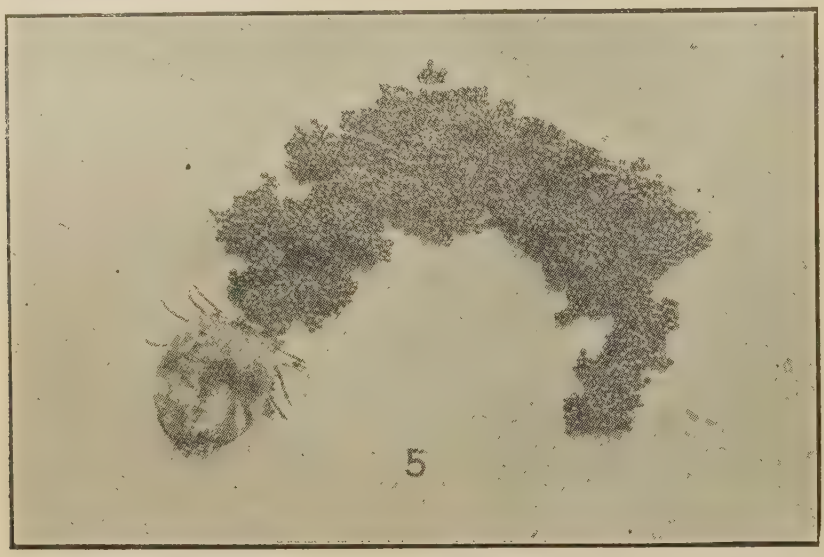
Lice and Certain Diseases. — Typhus fever is transmitted from man to man by the Body Louse (Pediculus vestimenti), and Beriberi probably by the Head Louse (Pediculus capitis).

Ticks and Certain Fevers. — Although ticks are not true insects yet they have been considered as coming under the field of the entomologist. In certain western states, viz., Montana, Idaho, Wyoming, Utah and Nevada, the Rocky Mountain Spotted Fever occurs and is produced by the bites of ticks (Dermacentor venustus, et al.) The African tick-fever is caused and carried by another tick (Ornithodoros moubata), the African Relapsing fever possibly by a tick, and the African East Coast fever of cattle by ticks (Rhipicephalus appendiculatus). The Texan fever of cattle is caused by a tick (Margaropus annulatus).

Other Diseases.

The terrible "hookworm" disease of the South is probably carried by the common house-fly. The causal organism (Anchylostoma duodenale) may also enter the skin from infected soil. *Pellagra* is transmitted, according to many authorities, by the bites of species of black-fly (Simulium) and by the ingestion of mouldy corn.

Leprosy, that most dreaded disease, is now believed to be transmitted by flies, fleas, mosquitoes and bed-bugs. Possibly also certain mites may be occasional carriers of the bacilli (B. leprae).



North American Fever Tick. (Margaropus Annulatus), 5 Female depositing eggs.
(Year Book, U.S. Dept. Agr. 1910.)

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REPORT OF DELEGATE TO THE FIFTIETH CONVENTION OF THE ONTARIO ENTOMOLOGICAL SOCIETY.

By Mr. J. C. Chapais.

Mr. Chairman and Gentlemen:—

Just a year ago, to-day, your Society appointed Mr. Winn and myself as delegates to attend the fiftieth convention of the Ontario entomological Sociey to be held at Guelph, Ontario, some time during last summer. This convention was held at the Ontario Agricultural College, at Guelph, and at Grimsby, Ontario, on the 27th, 28th and 29th of August. I left my home on August 25th and arrived at Guelph on the morning of August 27th. We were in all thirty-five delegates gathered from England, many provinces of the Dominion, and the United States. It was arranged that we were to be the guests of the College during the two first days of the convention. We had our rooms at the Macdonald Hall, and for our meals were the guests of Dr. G. C. Creelman, whose frank and hearty hospitality made our sojourn at Guelph most agreeable. The meetings were held in the Massey Hall. On Wednesday afternoon, at the first meeting under the presidency of Reverend C. J. S. Bethune, the thirty-five delegates had an opportunity of presenting addresses from their Societies. On the evening of the same day, all the delegates attended a very pleasant reception at the residence of the President of the College, where they had the pleasure of meeting Mrs. Creelman and other ladies, some of whom were wives of delegates, etc., whose company made an agreeable diversion to the arduous work of the first meeting. On Thursday, three other meetings took place in the Massey Hall, and, then the convention was adjourned to Grimsby where an excursion was arranged for the next day.

The whole of Friday was devoted to the excursion to Grimsby and the noted Niagara Fruit District. The excursionists had lunch at "The Village Inn," Grimsby; afterwards, about half of the party took part in a stroll in the hills surrounding the town in search of entomological and botanical specimens, while the other half had a very pleasant drive to visit the fine peach and pear orchards of the neghbourhood and sample many of the good fruits grown there. Nothing finer to inspect than those well kept orchards, carefully cultivated and free from insect pests and fungous diseases, especially for a man like myself, as this was the first opportunity I had of visiting such peach and pear orchards and of gathering from the trees some luscious fruits they were bearing.

I cannot enter here into the names of the societies represented at that convention, of the program followed at the meetings, nor give the names of the dele-

gates, as all this will be found in the report of the Ontario Entomological Society for 1913.

The only thing I wish to mention is the cordial reception we received from the President and several of the professors of the Ontario Agricultural College, the Officers of the Ontario Entomological Society, and the Grimsby orchard owners, for which we are very thankful.

THE WHITE CYSTOPUS.

J. C. Chapais, St. Denis-en-bas, P. Q.

Everybody who owns a garden knows the noxious weed commonly called "Shepherd's Purse," in French *Bourse-à-pasteur,* but, in case some one should not know it under this appellation, I will give here a brief description of it, as I am going to mention it in the short note I wish to write concerning the white Cystopus.

Description.—Names: Capsella Bursa Pastoris.—Shepherd's Purse, Capselle, *Bourse-à-pasteur.* Introduced from Europe. Annual and winter annual. Few plants are so variable in size and appearance. It may be bright green and nearly smooth, or gray from very short appressed hairs. A seed-bearing plant may be a dwarf, little more than an inch or two high, or a vigorous branching plant, three feet high, with many pods. There may be at the base a vigorous rosette of leaves, or none at all. The leaves may be deeply cut, pinnatifid, or without any teeth or division. The stem-leaves are for the most part arrow-shaped, with two sharp ear-liked projections, one on each side of the stem. The flowers are small and white. The only part of the plant which seems to be constant is the seed-pod, which is flat, triangular in shape, one-fourth of an inch long, wedge shaped at the base, notched at the top, with the outer angles rounded. Each pod contains about twenty seeds. (Farm Weeds of Canada).

I have just stated that it is on account of the white Cystopus that I have mentioned Shepherd's Purse. This plant of the Cruciferous family, is the favorite foster-mother of that fungus commonly named cabbage mildew and which is nothing else than the white Cystopus (Cystopus candidus). Here is what we find in "The Century Cyclopedia" about the Cystopus: "It is a genus of parasitic fungi, belonging to the family Peronosporeae, and characterized by conidia produced in chains on very short conidiophores, forming compact sori upon the supporting leaf." Cystopus candidus is injurious to the cabbage, radish and other cruciferous plants. I have very often found it on Shepherd's Purse, and four or five times during my life time, I have seen its attacks on cabbages and turnips. In fact, this fungus will feed o nall crucifer plants. As it is seen in greater quantity than usual this year, I thought that it would be valuable to call the attention of gardeners to it, especially as it is seldom mentioned in our horticultural literature. While giving here its description, I have before me a plant of Shepherd's Purse which is covered with it, and at the same time, I am guided by an article of Mr. E. Noffray, printed in "Le Journal d'Agriculture Pratique" of Paris, France.

The White Cystopus shows itself as white pustules on the leaf petioles, some pustules of which are seen also on the limbs of the same leaves. These pustules are as many as 18 to 25 on an inch. The conidia of these pustules emit zoospores which produce by germination mycelial filaments having a deforming property,

and which when they develop bring on small blisters of 0.31 to 0.39 inch in size. Each of these spores carries a vibratile cilium. These zoospores develop upon the petioles of the leaves, where they are carried by drops of rain or dew, lines of blisters brought more or less near together. These blisters which wind around the leaves in irregular spirals, are filled with fertile filaments. When the zoospores are accumulated on a secondary rib, or the mid-rib of a leaf, at from 1 to 1 1-2 inch from the end, they unite in a shorter and lesser blister often curled, closed and filled with filaments. Some time after the formation of these blisters, the fertile filaments appear here and there on the outer surface of the deformed part. The mycelium, when carried from the Shepherd's Purse plant to the cabbage, appears on the last in the form of blisters having a diameter of three inches by about two inches covered with mycelium filaments.

It is important, if one is anxious to get rid of the White Cystopus, to wage war on the Shepherd's Purse plant first. Then if some forgotten individuals of that plant have caused the propagation of the fungus and its spread upon cabbages or turnips, attention must be paid to the young plants. Discoloured spots having a yellow appearance indicate the presence of the Cystopus. Frequently, by eradicating the first invaded plants, the remainder of the bed is saved. If the spreading of the cabbage mildew has been discovered too late, the lower leaves of the headed cabbages should be picked off and burnt. No stalks should be left in the ground, for, if left they are prone to send forth new leaves continuing to spread the invasion. After all this has been cleared, if the disease has developed strongly, it is prudent to sprinkle the ground with a solution of sulphate of copper to insure the destruction of the spores spread on the ground.

A PLEA FOR THE PUBLICATION

of a

NEW ILLUSTRATED FLORA of the PROVINCE of QUEBEC

Rev. Brother Victorin, Longueuil, P. Q.

In answer to the invitation of our most active and devoted President, I at first intended,—to comply with a well-established tradition in our Society,—to rouse indignation about this or that poor little creature charged with the grievous offence of trying to "live its life" by our side, in our orchards, gardens and meadows. But, under the impression that this barbarous plea will be more consonant with the personal feelings of some here present, I leave it to them, and I will rather draw your attention to a question of indirect interest, already debated in our Society.

In fact, I read in the Annual Report of "The Quebec Society for the Protection of Plants" for 1911-1912: "Many years ago, abbé Provancher published a work entitled: *Flore du Canada*" in two volumes, which has been out of print for some years and is now very difficult to procure. No work on systematic botany has taken its place in Quebec, consequently this phase of the study of plant life has been to a large extent neglected in the French Schools of the Province. I would therefore suggest that the Society request the Government of the Province not only to reprint a revised edition of Provancher's work, but also to publish

a school edition of same. The publication of these two editions would give a stimulus to the study of plants, and indirectly would tend to a better knowledge of weeds on the part of the rising generation."

As an admirer of Abbé Provancher, and one who, moreover, has followed closely in his footsteps for the last ten years, I beg leave to express an opinion on the matter.

There is no doubt that the name of Provancher has a standing of its own, and a prominent one too, in the history of Canadian science. Under struggling circumstances, without special training nor laboratory facilities, far from technical libraries he has however accomplished a stupendous amount of work and cleared the ground most efficiently for future workers.

The *"Flore Canadienne"* was a most extraordinary achievement for the time, and though fifty years have rolled over this book, fifty years of feverish activity, though it has now run obsolete on account of the steady advance in the botanical field, we must admit,—whatever our langage is—that no other book, as yet, has attempted to displace it.

Nevertheless I venture the statement that the proposal of reprinting Provancher is a rather an acknowledgment of inability. And to go the whole length of my opinion at once, I consider that such a reprint, if the essential features are preserved, would be a step backwards.

In the course of the last half-century, the systematic botany of North America has benefited by the labors of a host of serious workers: virtually unknown regions have been penetrated, thousands of new species established and the nomenclature more than once disturbed and subjected to new regulations.

Mentioning but the Province of Quebec, the careful survey of Prof. M. L. Fernald and his Harvard friends has shown in the Gaspé Peninsula the existence of an altogether unknown flora akin to that of the Rockies. Of this fact, of course, Provancher had no suspicion.

Such genera as *Isoetes, Potamogeton, Juncus, Carex, Rubus* and especially *Crataegus* have revealed an amazing wealth of species. Everybody knows the hawthorn and appreciates it more or less, but very few would suppose that the American species now number about 1,000. The joint work of Charles Sprague Sargent and J. G. Jack have shown the limestones ridges of Montreal and the continguous shales to be one of the richest regions in the whole world in forms of *Crataegus*. Though there is much yet to do in the genus, it can already be foreseen that the new Flora of Quebec will be bound to treat as much as 60 or 70 species.

I do not wonder now about my perplexities while first trying to separate the Longueuil *Crataegi* with Provancher as a guide. It was only when I opened the pages of the seventh edition of Gray's Manual and when I was made acquainted with Mr. C. S. Sargent, that I began to see something into it.

Provancher believed the distribution of plants in Canada to be zonal according to latitude, and consequently to be approximately indentical from the Atlantic coast to the Pacific; this belief he had in mind when he entitled his work: "Flore Canadienne". This generalisation has not proved successful. We know to-day, by the collections of Macoun and others, that the Prairie region, the Rockies, the Pacific slope have each an endemic flora, and a "Canadian Flora" embodying the whole of the territory, would be an immense enterprise.

Properly speaking, Provancher covers but the central portion of the Province

of Quebec. The list with analytical keys, annexed by abbé Moyen to his own "*Traité de Botanique*", though more complete is yet fragmentary, and must undergo the very serious criticism of lacking the descriptions necessary to every one except the trained specialist.

For these several reasons, I believe that a reprint of Provancher would either be of mere bibliographical or historical interest, or would oblige to work such a havoc with the plan and the scientific material, that nothing would stand of the original book.

I think that the demand is for a new "Flore Illustrée de la Province de Québec", embodying the Ungava Territory, and brought up to the present state of botanical science. I take the liberty of insisting on the illustration as it is the principal feature of usefulness to the general public.

To be candid, I do not consider the publication I suggest as a very easy task. Difficulties are numerous, and foremost among them would be the cost of production. The plates alone in such a work could not be secured for less than $3,000. I hardly think that any private enterprise in this line could be possible. It seems that the provincial Government should take charge of the work through one of its departments, subsidizing it as the work goes on.

I have no information as to whether our English-speaking friends feel this lack of suitable books, as keenly as we do. The unrivaled botanical writings published in the last twenty years in the United States generally include the Province of Quebec in their range. I mention as covering the whole subject: "Illustrated Flora" (Britton & Brown, 2nd Ed.), "Gray's Manual of Botany" (7th Edition), the last mentioned having included for the first time the results of Fernald's investigations in the Gaspé Peninsula. At all events, once the "Flore Illustrée de la Province de Québec" completed, the translation might readily be made at very low cost.

These considerations, Mr. President, I respectfully submit to you and the meeting. "The Quebec Society for he Protection of Plants" will have done much for the Province and the fulfilment of its particular object, if it can induce the Provincial government to undertake this much needed work. For, I am thoroughly convinced that the indifference which the public at large shows towards nature study is principally due to a want of adequate and readily accessible literature. Some might object that such a scientific literature would logically result from increased interest in botanical studies. If so, we are arguing in a circle, and such a situation will only be cleared up by an energetic effort having its expression in "La Flore Illustrée de la Province de Québec."

The INJURIOUS FLEA-BEETLES of the PROV. of QUEBEC

By Arthur Gibson, Chief Assistant Entomologist, Ottawa.

Among the destructive insects which attack the foliage of many plants, the flea-beetles must be recognized as an important group. They are closely related, and all belong to the same family of Coleoptera, viz., the *Chrysomelidae,* the members of which are known popularly as "leaf-beetles".

The Flea-beetles are most injurious in spring, at which time the young seed leaves of much plants as turnips, radishes, etc., are visited by large numbers of the adult insects and quickly destroyed. Numerous small holes, in some of the

larger leaves as many as several hundreds, are eaten into and through the leaves; in fact, large portions of the foliage are often completely eaten.

In the Province of Quebec there are five different kinds of flea-beetles which I should like to direct special attention to at this meeting. These in the order of their importance are as follows:

THE TURNIP FLEA-BEETLE, (*Phyllotreta vittata Fab.*)

This is one of the commonest and most regularly-occurring of the destructive flea-beetles which attack vegetables. It is, also, sometimes troublesome in flower gardens, attacking foliage of stocks and wall flowers. It is a small species of a shining-black colour and in length about one-sixth of an inch. On each wing-cover there is a wavy band of yellow. The over-wintering beetles appear early in the season, and in the latter half of May and June much injury is done to

Turnip Flea-beetle enlarged 12 times. (After Riley U.S. Dept. Agr.)

young radishes, turnips, cabbages and other Cruciferous plants. The chief damage is to the seed leaves directly these appear above ground and just when the young plants can least withstand such attack. Later, when the rough, true, leaves are formed, the plants, as a rule, are able to make more growth each day than the beetles can destroy. The female beetles deposit their tiny, white eggs upon the roots of the plants and the young grubs feed thereon oftentimes doing considerable injury; it is probable, however, that this injury is largely confined to weeds belonging to the mustard family.

THE POTATO FLEA-BEETLE (*Epitrix cucumeris Harr.*)

One of the most destructive of the flea-beetles which occur in Canada is the Potato Flea-beetle, a very small species, measuring from about one-sixteenth of an inch to one-twelfth of an inch in length, black in colour with pale-reddish legs. The foliage of potato and tomato are freely attacked by the beetles, which eat numerous small holes in the leaves. In addition, the beetles have been found feeding upon cabbages, cucumbers, beans, tobacco, squashes, pumpkins, wonderberry and other plants. As a rule, the insect is more numerous in hot, dry seasons. The beetles pass the winter in dry sheltered spots and make their appearance

early in spring; the females soon deposit their minute eggs upon the roots of common weeds of the Nightshade family, the resulting grubs feeding underground and changing there, when full grown, to the pupal state. The beetles, when they issue, attack the leaves, and in some years towards the end of July

Potato Flea-beetle; line at side indicates natural size. (After Chittenden, Bull. 19, N.S., Div. of Ent., U.S. Dept. Agr.)

or early in August serious injury is effected. In the spring the young leaves of such plants as have been mentioned above are often entirely eaten by the overwintering beetles.

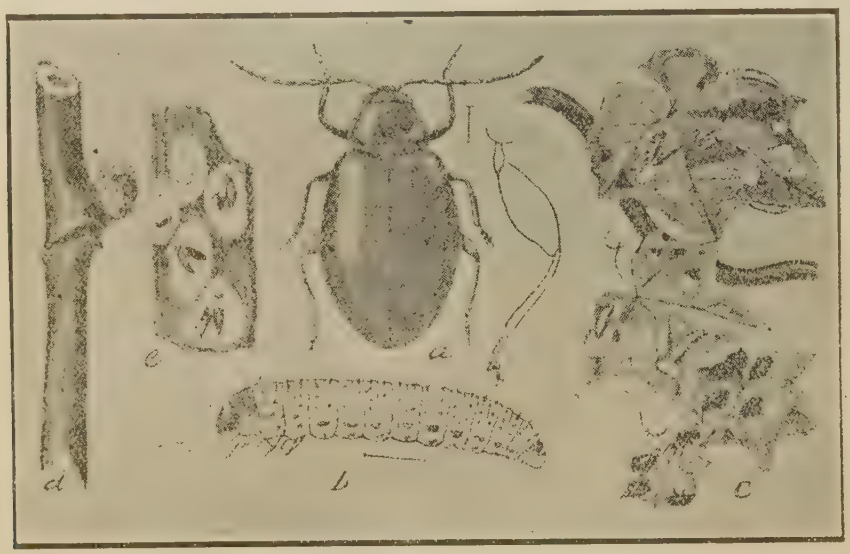
THE ~~GRAPE VINE~~ FLEA-BEETLE (~~*Haltica chalybea Ill.*~~)

This common flea-bettle, so called from the conspicuous red patch on the top of the head, is jet black in colour and in length about three-sixteenths of an inch. The body is slender and elongated. In Ontario, Quebec and other eastern provinces the beetles are sometimes extremely numerous. The insect has a very wide range of feeding plants. It has been particularly destructive early in the season to the foliage of potatoes, beans and young grapes, as well as to many kinds of deciduous shrubs. Large numbers of the beetles have been found upon flowering plants in gardens such as marsh mallows, rose mallows and Japanese honeysuckles.

THE GRAPE VINE FLEA-BEETLE (*Haltica chalybea Ill.*)

The tender buds of grape vines are often completely eaten by swarms of thes flea- beetles which leave their winter quarters early in spring. In Ontario, grape growers in some sections have suffered considerably from the attack of this beetle which is one-fifth of an inch long, varying in colour from a steel-blue to green. In Quebec province, fortunately the insect is not complained of to a serious extent, but it has been reported from the Eastern Townships and deserves watching. About the time the leaves have expanded, the young grubs hatch and eat out irregular holes, becoming full-grown in three or four weeks, at which time they are one-third of an inch long and of a dirty yellowish-brown colour with black, shining, bristle-bearing tubercles. When mature, the grubs drop to the ground and enter the arth to change to the pupal state, and in a week or two the beetles emerge. As these beetles pass the winter in the perfect state beneath dead

leaves and other rubbish, it is important that all such refuse be gathered up and burned in autumn so as to reduce as much as possible the opportunities for these insects to hibernate near the vines. Grape growers should watch for the appearance of the insects when the buds are forming, and when they are detected, a strong spray of either Paris Green or arsenate of lead should be applied to the vines so that every bud will be literally soaked. The buds will stand as strong a dose of Paris Green as one pound in 75 gallons of water, with an equal amount of freshly slaked lime added. In a few days the application should be renewed,



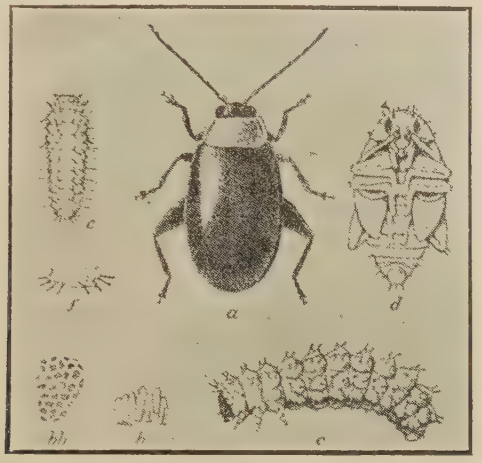
The Grape-vine Flea-beetle ; *a*, adult enlarged 7 times, hind leg enlarged at right ; *b*, grub enlarged 6 times ; *c*, grubs and beetles on foliage—natural size ; *d*, beetle feeding on bud ; *e*, diseased beetles. (After Marlatt, U.S. Dept. Agr.

or sooner if the first treatment is washed off by rain. Arsenate of lead is recommended as strong as eight pounds to a barrel of water. In small gardens the practice of jarring the beetles from the vines into an inverted umbrella, and then dropping them into a pan containing coal oil and water, is of value. When the grubs are found feeding upon the leaves, spraying with Paris Green or arsenate of lead in the ordinary strengths (one pound of Paris Green to 160 gallons of water, or arsenate of lead 2 pounds in 40 gallons of water) will give relief. The destruction of the grubs is an important factor in the control of the insect, because every grub killed means one beetle less the following spring to attack the buds.

THE BLACK MARGINED FLEA-BEETLE (*Systena marginalis* Ill.)

Occasionally in eastern Canada outbreaks of this insect have appeared in the middle of the summer, considerable injury to certain forest and shade trees resulting therefrom. At Ottawa, the worst attack has been in August, when the beetles appeared in large numbers feeding chiefly on elm, oak and hickory. This flea-beetle is from one-eighth to about three-sixteenths of an inch long, yellowish-

brown in colour with the thorax and wing-cases margined with black along the outer edge. The latest date on which the writer has found the adults feeding is September 15th, (on oak).



Spinach Flea-beetle: *a*, adult beetle; *b*, egg mass; *bb*, sculpture of egg; *c*, full grown grup; *d*, pupa; *e*, newly hatched grub; *f*, abdominal segment of same: *a*, *c*, *d*, five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged. (After Chittenden, Bull. 19, N.S., Div. of Ent., U.S. Dept. Agr)

In addition to the five species which I have mentioned, there are two others which some seasons are fairly numerous in some sections of Quebec province. These are the Spinach Flea-beetle, *Disonycha xanthomelaena* Dalm., which in the United States feeds chiefly upon spinach or beets. Little injury is done by this

Horse Radish Flea beetle, enlarged 9 times. (After Chittenden, Insect Life, Vol. VII.)

insect to cultivated crops in Canada. The other species is the Horse Radish Flea-beetle, *Phyllotreta armoraciae* Koch., which has been reported from Montreal. The only cultivated crop attacked is the horse radish. At Ottawa I have found the beetle on garden radish.

neglect on the part of the farmer—failure to combat orchard diseases and pests, for pests mean defective fruit and often also dead trees. Spraying is the only way by which this may be prevented.

For of the three fundamental principles in fruit-growing, spraying perhaps stands at the top as the most important. Orchards may be left unpruned and uncultivated, in sod in a word, but when left unsprayed, the fruit is worthless. It is the lack of spraying which has hastened the decline of hundreds of *farm orchards* and caused the man with a few trees to feel that it is of no use to attempt to grow fruit.

But there is a greater opportunity to-day with the average farm orchard consisting of 25 to 50 trees, than ever before. There is greater certainty that the trees may be productive of high-class fruit, and that the family cellar may be filled each fall with nice, luscious, juicy, red Fameuse or McIntosh or other varieties of recognized worth, than there was half a century ago. The most destructive diseases and insects are known, thanks to the good work done all over the country by this Society and similar ones; their habits, their likes and dislikes and their time of appearance are well understood; and how to control them is no more difficult than doing any other work on the farm.

As we first pointed out in the beginning of this paper, the time and expense required to spray the orchard is trifling, compared to the value of the fruit which is produced upon it. 34 cents a tree is the approximate cost of the whole work for a season, that is for the four applications, and if not willing to make the four, well there are three that should always be made. A bearing tree of a certain age will bear from 3 to 12 or 15 bushels of apples, according to the year. Why is it then that there are so few home orchards sprayed? The excuse can not be given that spraying does not pay; the lack of time can hardly be held up as a legitimate reason; ignorance of how to do it is a very feeble way of getting out of spraying. Isn't it just real laziness?

In spraying, like every job on the farm, the hardest part is to get at it, particularly so when there are only a few trees to be sprayed. But there is no work on the farm that pays better the time and effort put into it than that of spraying.

Insead of cutting down the old orchard, spray it. Cut down the trees that are dead or nearly so and plant new ones to take their place. Neglect the pruning if you must; let grass grow in the orchard and do not cultivate if you want to, but spray and spray right, thoroughly. Every farm ought to have its orchard and spraying machine. Why last year, I think that the caterpillars had this advantage that they compelled many to spray, for I hear that the farmers bought more spraying machines last year than they did in the last five years or more. We should not be compelled to do good work in such a manner. Apples, plums and pears ought to form just as an essential part of the home diet as ham and eggs and potatoes.

There is no reason why the farmers should leave the growing of fruit in the hands of specialists, only by abandoning the home orchard. There is no more reason for this than for every farm home giving up the potato patch or the truck gardening for home. A poultry specialist raises chickens that take the blue ribbon, but is that any reason why the farm chicken yard should become either a specialty or be abandoned? No. The farm orchard is an important part of the farm, and the only fault is that there is not more of them, and more *spraying done in the neglected orchards of the Province.*

We have not reached the stage when we can proclaim the the passing of the

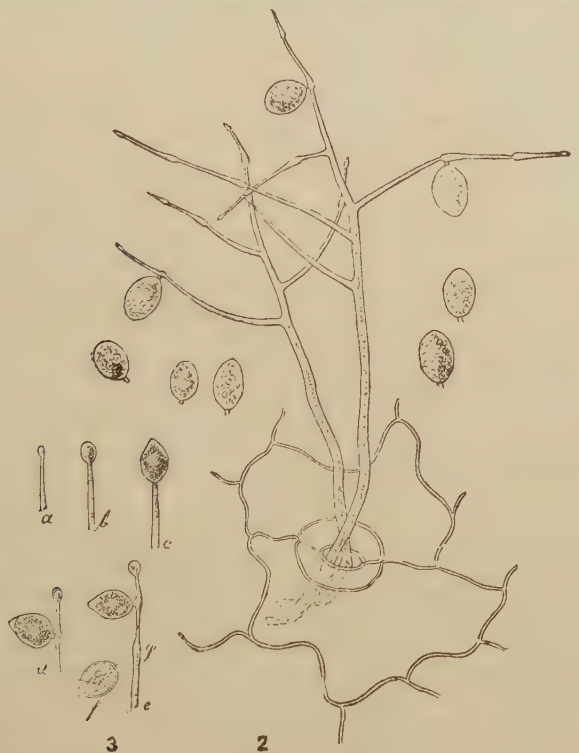
farm orchard, but rather the advent of the spraying of the farm orchard. The small orchard on the farm may be sprayed as well as the big commercial orchard. Spraying machines for such purposes are not expensive. The cost of the work is very low and the value of the produce is high, very high in fact, considering the low orchard in the Province. Then let us have the old farm orchard sprayed and sprayed right, and more trees planted to supply the coming generations. It will be an investment in health, happiness and prosperity.

THE DOWNY MILDEWS

By E. Melville Du Porte, Macdonald College.

The Downy Mildews constitute a family of fungi known to the systematist as the Peronosporaceae. They should not be confused with the powdery mildews which belong to an entirely different group of plants, differing from the downy mildews in habit and morphology.

Characters. — The fungi of this family are entirely parasitic and several of them are responsible for well known destructive diseases of cultivated plants.



Late Potato Blight. Showing the method of producing spores.

The mycelium, or vegetative portion of the fungus, is made up of branched, unicellular filamentous hyphae. It is produced abundantly and, except in the genus *Phytophthora,* is always intercellular. In order to obtain the necessary

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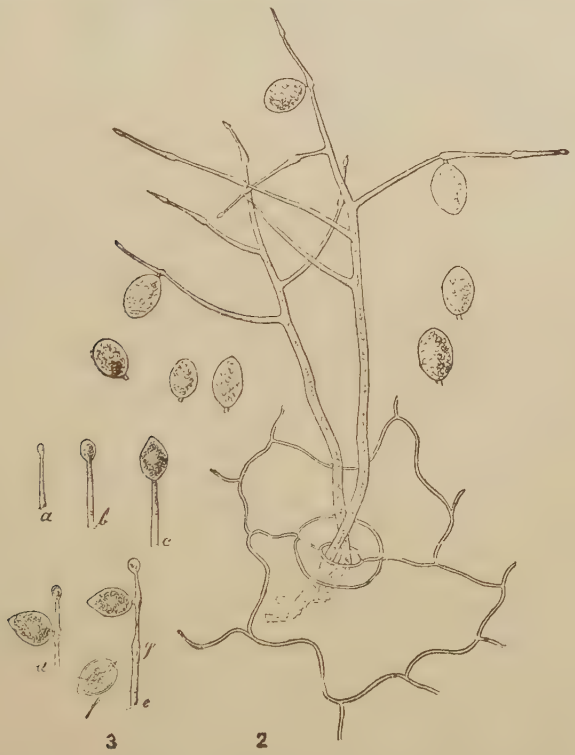

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nourishment which exists within the cells of the host, the mycelium gives off specialized branches known as haustoria. These penetrate the cells and function as absorbing organs. There are two types of haustoria, in some genera they are button shaped, in others they are branched and filamentous.

The conidiophores are borne by the mycelium in the neighbourhood of the stomata. They pass out through the stomata singly or in small groups, giving a characteristic downy appearance to the infected areas, from which the popular name of these fungi is derived. The conidiophores are branched, the method of branching serving as a convenient means of generic separation. Conidia or summer spores are produced abundantly on the ends of the branches of the conidiophores. In shape they are typically ovate to oval and their length averages about 1-1200 of an inch. They are easily disseminated by wind or water, and it is by these means that the fungi are able to spread so rapidly during the summer months.

Oospores are produced by most species within the tissues of the host plant. These resting spores are enclosed within two thick walls. The inner one is smooth and light coloured and is known as the endosporium. The outer coat or exosporium is darker in colour and rough on the outer surface. The oospores result from sexual fusion and are useful in tiding the fungus over the winter, or other unfavourable conditions.

Germination of Spores. — When a conidium falls on the surface of a leaf, if conditions are favourable it may germinate in one of two ways, depending on the genus to which it belongs. The first method of germination is by sending out a germ tube directly. This tube enters the tissue of the host through a stoma, and develops into a new fungus-plant. In some genera, instead of germinating directly, the conidia give rise to minute biciliate zoospores or swarm spores. These swim around in a drop of water for a few hours, then become stationary and send out a germ tube which, entering the tissue of the host through the stoma, develops into the intercellular mycelium. In Phytophthora (Late blight of Potato) both methods of germination have been observed.

Effect on the Host. —These fungi attack the leaf, stem, fruit and even the underground parts of a large number of widely separate plants. On the leaf they are characterized by brownish or yellowish discolorations, more or less irregular in outline bearing the downy conidiophores on the underside. In moist weather these spots usually spread rapidly until the entire leaf is affected. Except in a very bad attack, the host is not killed. The leaves however may die and fall off, thus retarding the normal development of the plant. In cases where the host is wild, the adaptation between it and the parasite in such that little or no injury results from the attack.

Conditions favouring or retarding the development of the fungus. — The climatal conditions favouring the development of the parasites are high temperature and humidity; and conversely, a dry cool climate is unfavourable. Berlese, in his monograph on the Peronosparaceae, states that there is little development below 20°C. (68°F.) and that the optimum temperature lies between 20°C. and 30°C. (68°F. and 86°F.)

General Methods of Control. — Wherever practicable, spraying with Bordeaux mixture will effectively control the downy mildews. It is interesting to note that the fungicidal value of copper sulphate was first discovered in connection with the downy mildew of the grape. The vine growers of Bordeaux, France,

used the blue stone solution on the vines bordering the highway in order to prevent passers by from stealing the berries. They soon observed that the treated plants were free from attack by the mildew while the others suffered severely.

As the resting spores live over the winter in the fallen leaves, it is advisable, when practicable, to burn all affected parts, and not to leave dead leaves and twigs lying on the ground.

Forms of Economic Importance. — Following is a list of the chief economic species.

The late Blight and Rot of Potato—*Phytophthora infestans* (Mont.) DeBary.

The Downy Mildew of the Grape—*Plasmopara viticola* (B. and C.) Berl. & DeToni.

The Downy Mildew of the Cucumber—*Plasmopara cubensis* (B. & C.) Humphrey.

The Onion Mildew—*Peronospora schleideniana.* DeBary.

The Downy Mildew of Clover and Alfalfa—*Peronospora trifoliorum.* De Bary.

Mildew of Lima Beans—*Plasmopara phaseoli* Thaxt.

Lettuce Mildew—*Bremia lactucae* Reg.

THE DOWNY MILDEW OF CLOVER AND ALFALFA.—This disease is worthy of special mention here, because, as far as I have been able to find out, it has not before been reported as a disease likely to be troublesome in America. In the summer of 1912, however, it was the cause of considerable injury to the first crop alfalfa on the Macdonald College Farm.

Symptoms. — The lower leaves of the plants are attacked first and the fungus seems to prefer the part nearest the stem, although it is usually spread over the entire leaf. Affected leaves turn whitish or yellowish, curl up and fall off. The lower surface of the leaf is grey owing to the presence of a downy covering of conidiophores and conidia.

Morphology. — This fungus possesses the characteristic mycelium of the family. The summer spores are produced as described above. Resting spores also are developed within the tissues of the leaves. When the leaves fall to the ground the resting spores remain alive throughout the winter and infect the plants in the following spring.

Effect on the Host. — The plants are not killed, but the crop suffers, directly through loss of leaves, and indirectly through the impaired vigour of the plants owing to the loss of the leaves.

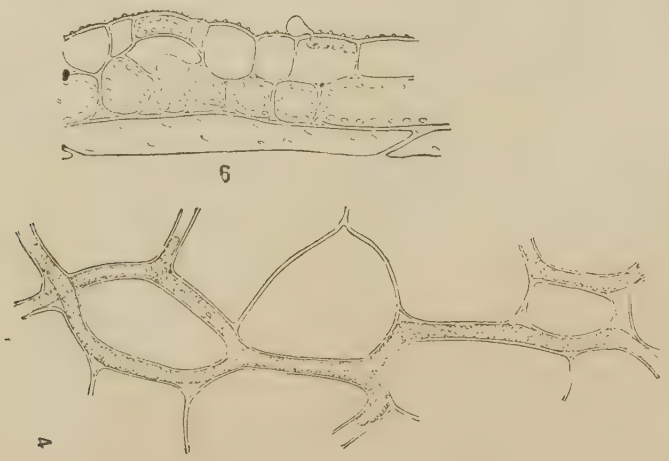
Control. — Spraying is impracticable in the field. If the crop is cut early, before the leaves containing the winter resting spores fall to the ground, this should prevent, or at least minimise, infection the following year. A systematic rotation of crops will do much to prevent this as well as other injuries. Alfalfa should not be sown on soil that is known to have been infected during the previous year.

THE LATE BLIGHT AND ROT OF POTATOES.

This is the oldest, best known and most destructive disease of the potato. It is troublesome throughout Europe, the North-East United States and the potato growing districts of Canada.

Symptoms. — The disease usually appears after blossoming. The symptoms begin to show about five days after infection. Characteristic spots are developed

on diseased leaves. In wet weather these spots present a purplish or brownish black water soaked appearance, the leaf is killed in one to four days and it falls limp and soon rots. In dry weather the spots are brown, the leaves are not so rapidly killed and they shrivel up soon after death. Infected tubers are characterized by the presence of brown or purplish spots on the skin. If the soil is wet and heavy, bacteria will attack the diseased tubers causing a wet rot. In dry light soils, the discolouration does not extend very far into the tuber, the diseased cells die and the spots become slightly sunken. This is the characteristic dry rot. Under favourable conditions the rot may develop and cause considerable loss in stored tubers.



Late Potato Blight. A downy mildew showing the threads between the cells of the leaf.

Morphology. — The mycelium differs from that of the other genera of this family in being partly intracellular. The haustoria are small and thread like. The conidiophores emerge singly or in small groups from the stomata on the under side of the leaf. Egg-shaped conidia are cut off from the tips of the conidiophores. The latter continue growing, pushing each conidium to one side as it is formed and producing another at the tip of the new growth. The conidia germinate directly, by sending out a germ tube, or indirectly, by the formation of zoospores. Resting spores are not known to be produced in the field but have been obtained in artificial culture media.

Infection. (1) Conidia may be carried from leaf to leaf by the wind.

(2) Conidia will pass from tuber to tuber in the soil, and will infect to a depth of six inches. The mycelium however will not pass from tuber to tuber through the stem.

(3) In storage, if the tubers are moist, conidia may be formed which will spread the disease.

(4) The mycelium may live over in seed potatoes.

Methods of Control.

(1) Planting of resistant varieties.

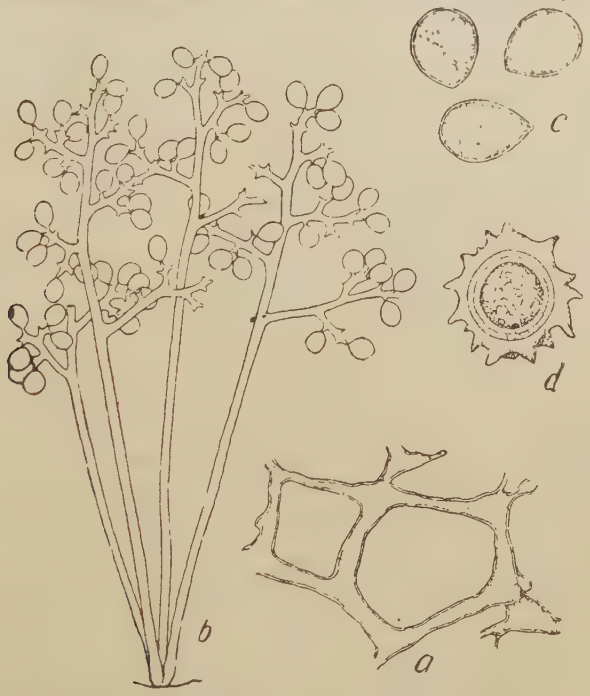
(2) Spraying with Bordeaux mixture is a very effective remedy. Experiments at the Vermont Station show that it pays to spray with Bordeaux even if the blight is not present.

(3) Keeping the storage house dry and cool.

(4) If the tops of the potatoes are infected, they should not be harvested until they have died down, unless the attack is particularly severe and the soil wet and heavy. Tubers harvested while the spores are abundant on the foliage are very likely to develop rot in storage.

THE DOWNY MILDEW OF THE GRAPE.

Symptoms. — The fungus may attack all the young portions. On the infected leaf, yellowish spots appear which are rather indefinite and irregular in outline and



Downy Mildew of Grape (Plasmopara viticola). A. portion of the mycelium from a diseased grape! B. A tuft of spore stalks ; C. Mature Spores : D. thick walled resting spore (from Longyear).

are more evident on the under surface. Shortly after the spots appear the conidiophores are given off through the stomata of the under side. When conditions are favourable for the development of the fungus, the leaves may be killed and will shrivel up and fall off. When the young fruit is attacked there is considerable loss.

Morphology. — The mycelium is of the typical form described for the family. It grows abundantly in the intercellular spaces. The haustoria are button shaped. Several conidiophores emerge from a single stoma and each becomes constricted in passing through the pore. Outside the stoma they again attain

their normal diameter. The branches are short, few in number and are produced near the end of the conidiphores. On germination, the conidia give rise to zoospores. Oospores are also developed.

Control. — Bordeaux mixture will usually keep this disease completely under control. Self-boiled lime — sulphur may also be used. Infected leaves, mummies, and other refuse which harbour the oospores should be burnt.

KEY TO THE COMMON GENERA OF THE PERONOSPORACEAE.

A. Conidia at first produced at the end of the conidiophore, but are pushed to the side as the fertile tips swell and continue their growth—*Phytophthora.*
AA. Conidia always at the end of the conidiophore. Tips of conidiophore branches do not continue to grow after conidia are formed.
B. Conidia germinate indirectly by means of zoospores.
C. Oospore free from wall of oogonium—*Plasmopara.*
CC. Oospore adherent to the wall of the oogonium. Conidiophores short, irregular—*Sclerospora.*
BB. Conidia germinate directly by means of a germ-tube.
C. Fertile tips arise from disk-like swelling. Germ passes out through terminal papilla—*Bremia.*
CC. Fertile tips branch-like, usually in pairs. No terminal papilla, germination lateral—*Peronospora.*

INSECTS OF 1913

E. Melville Du Porte, Macdonald College.

The season of 1913 was a remarkable one in this district on account of the long continued drought. There was little rain and that fell in small quantities which soon evaporated from the parched soil. Official records at Macdonald College show that during the five months from May to September, the rainfall amounted to only 9.7 inches. This was distributed over 43 showers and as a light shower evaporates before the water has been able to sink very far, it can be readily seen that the precipitation was not a very effective one.

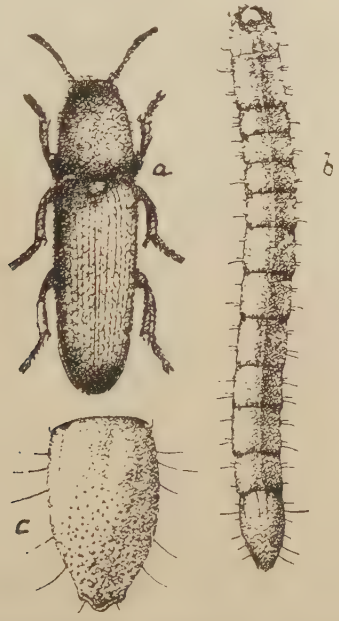
The temparature was moderate throughout the season.

Several forms of vegetation suffered severely, as an immediate result of the drought, and many from the ravages of destructive insects, to the rapid multiplication of which the season seemed to be conducive. Several injurious insects were abundantly in evidence last season and also several predaceous or parasitic forms.

The influence of the weather conditions on the number and prevalence of phytophagous insects has not, as far as I know, been exhaustively studied. A bright, dry season with moderate rainfall favours their increase, whereas a very wet season has the opposite effect. Dr. Forbes of Illionois, says that in very wet weather "the sap of the plant may become so dilute, through excessive absorption of water by the roots that it loses its nutritive value and insects dependent on it are not so well nourished as by the denser sap of a plant growing in a dryer soil. They consequently grow less thriftily and multiply less abundantly, and may even diminish rapidly in numbers during a wet season, while if the

weather were dry and their food nourishing they would increase steadily at a geometrical ratio. After a year or two or three of drought the intelligent farmer will be more watchful for the first appearances of insect outbreak than after a series of unusually wet years."

Heavy rains may effect direct mechanical or physiological injury by beating to the ground and drowning many insects especially in the younger larval stages. A rainy season may also indirectly exert a pathological influence in diminishing the numbers of certain insects, by bringing about favourable conditions for the spread of furgous parasites of these insects. So it is likely that a very wet season will always act as an inhibiting factor in the general increase of insect pests. On the other hand, a dry season, not dry enough to prevent the growth of their food plants, is conducive to the abundant multiplication of insect pests, especially those with two or more broods. It must be remembered however that conditions favourable for the development of injurious insects—viz., optimum nutritive and climatal environment—are also favourable for their parasites. Thus last year, while there was an abundance of certain harmful forms there was also a marked abundance of predaceous and parasitic insects.



Melanotus cribulosus: The Corn Wireworm; *a*, adult beetle; *b*, wireworm or larva; *c*, last segment of larva.

Cutworms, wire-worms and white grubs were all found in the soils of the college farm, but with the exception of two species of wire-worms did not do very much harm. These wire-worms were the larvae of *Melanotus communis* and *Agriotes mancus* which were responsible for the destruction of much seed corn sown in a field that followed sod. *Melanotus communis* was the most common wire-worm observed both in the larval and the adult stages. Both of the above species, as well as others, were observed in the sod lands.

Clover Insects. — There was little clover at Macdonald College last season owing to the unfavorable conditions during the preceding winter. In the sod lands, however, in which clovers and grasses had been grown mixed, considerable clover survived. This was badly affected by three pests, the Clover Chalcid (*Bruchophagus funebris*), the clover-root Borer (*Hylastinus obscurus*), and the clover mite (*Bryobia pratensis*).

Agriotes mancus (Wheat Wireworm) ; *a*, adult beetle ; *b*, wireworm or larva ; *c*, last segment of larva.

The common red, and mammoth red clover are the only ones in the seed of which the chalcid larvae were found. The adults were observed flying about the heads of the alsike clover but no grubs were obtained from this variety. The grubs were first observed in the seed of the red clover in July. At that time, I could not find any adults about the heads. In the laboratory adults began to emerge about the middle of July, and after that, and throughout the greater part of August, they were present in large numbers depositing their eggs in the young seeds. In the small experimental plots of the Cereal Husbandry Department there was considerable loss of seed caused by this insect. In many heads examined there was complete failure to ripen seed although most of the flowers had been fertilized. The number of heads in which over 50 p.c. of the seed was eaten was comparatively large. If the growing of clover seed in quantity was contemplated, this insect would be one of the most serious problems.

The Clover-root Borer was especially destructive to the old plants in the sod lands. The Clover Mite was very abundant during last summer. Areas affected could be readily seen, as the leaves of the plants turned yellow and wilted, the plants showing abundant signs of impaired vigour.

The Clover-leaf Midge (*Dasyneura trifolii*) was also found quite commonly on the leaves of the white clover. From it a small chalcid parasite was reared.

Flea-Beetles. — There were four species of flea-beetles conspicuously no-

ticeable; others being present but not in large numbers. The Turnip Flea-beetle (Phyllotreta vittata) was abundant in the rootfields and early in the season did considerable damage to the young urnipst. Another pest present during June and July was the Wavy Flea-beetle (P. sinuata). This insect is interesting as it has probably not before been reported as a pest in the province. It is an introduced species wide-spread in Europe. In 1889, Horn described it as occurring in the New England States south to Georgia and west to Missouri. Sanderson speaks of it as feeding on the wild pepper grass (Lepidium virginicum) of the middle and southern states. It entirely destroyed the cress and caused considerable loss among the radishes in a small vegetable garden at the College. The adult insect is hardly distinguishable from P. vittata. It is, however, larger than the latter, and the inner margin of the basal portion of the yellow stripe is nearly parallel to the suture, while in *vittata* it is incurved. In *sinuata* the fifth joint of the antennae of the male is much larger than the corresponding joint in the Turnip Flea-beetle. The larva is a small six-legged grub, greenish with numerous black tubercles on the body segments, and with a black head and pronotum. It mines into the leaves of the host plant, destroying the mesophyll tissue. When ready to pupate it falls to the ground into which it burrows, builds a protective cell around itself and changes into a small yellow pupa.

The broods evidently overlap as both larvae and adults were found feeding on the leaves at the same time. A small hymenopterous parasite was reared from the larvae of this insect.

Potatoes suffered severely from two flea beetles. The Potato Flea-beetle (*Epitrix cucumeris*) was most abundant, but there were also large numbers of *Systena hudsonias* feeding on the leaves.

It was impossible to separate the amounts of injury caused by these two insects.

The Cabbage Butterfly (*Pontia rapae*) was extremely abundant on cabbage, cauliflower and other cruciferous plants.

Its parasites, however, were equally active. The ones which did most effective work were the chalcid *Pteromalus puparum* and the Braconid *Apanteles glomeratus*.

The Cabbage Root-maggot (Phorbia brassicae) caused considerable reduction in the yield of early cabbages. From the pupae of this insect I reared a Cynipid parasite *Trybliographa anthomyiae*. There were also present in the infected soil large numbers of the predaceous staphylinid *Aleochara nitida* which preys on the maggot. A species of *Trombidium* is known to feed on the eggs of the cabbage root maggot; such a mite was found in abundance in the inefcted fields, but it was not observed eating the eggs. As usual only the early cabbages suffered.

The turnips of the experimental plots were attacked last season by *Phorbia fusciceps*, an Anthomyian very much resembling the cabbage root-maggot. It is almost impossible to distinguish the female of *fusciceps* from that of *brassicae*. The only reliable differentiating character is to be found in a comparison of the hind legs of the male. In P. *fusciceps* there is a row of "short, rigid, bristly, hairs of almost equal length on the inside of the tibia. In the case of the cabbage maggot the male bears a characteristic tuft of long hairs at the base of the hind femur.

The Beet-leaf Miner (Pegomyia vicina) attacked the spinach in the spring

causing considerable loss. The beet did not suffer very much but some varieties of mangels were severely attacked. The Hemipteron, *Coriscus ferus,* was observed to be abundant on the affected leaves of the mangel. I did not observe it feeding on the maggot in the field but specimens brought to the laboratory fed greedily on maggots put in the same cage. A number of the miners were found dead within the tissues of the leaves, dried and flattened. This was probably the work of the predaceous bug. I also bred from the pupae of *P. Vicina* a small Braconid parasite and have observed parasitic larvae (probably of this Braconid) within the maggot.

Fig. 2.—*Pontia rapæ*: *a*, female butterfly; *b*, above, egg as seen from above; below, egg as seen from side; *c* larva in natural position on cabbage leaf *d*, suspended chrysalis—*a*, *c*, *d*, slightly enlarged; *b*, more enlarged. (From Chittenden.)

Later in the season another miner similar in habits and appearance to P. vicina was found along with this in the mangels.

The Cabbage Aphis was present in force but its enemies, the lady birds, were exceptionally numerous and effectively kept it in check.

The 12-spotted Asparagus-Beetle (Crioceris 12-punctata) was abundant but no specimens of C. asparagi were observed.

The Forest and Orchard Tent-Caterpillars (*Malacosoma disstria* and *M. Americana*), were the most abundant and destructive insects of the season. All unsprayed orchards in this vicinity were completely defoliated and many shade trees as well as acres of woodland were entirely stripped of their leaves. Fortunately the parasites of these insects were more abundant than in the preceding year. Large numbers, especially of the Orchard Tent-caterpillars were destroyed in the larval stage by a bacterial disease, and of the pupae I collected at the end of June about 45 per cent were parasitized by insect parasites. Of these parasites the most abundant was the maggot of a Tachinid fly. Some ichneumonids were also collected.

It may be of interest to note that the robber fly, *Dasyllas flavicollis* was observed preying on the adults of *M. disstria,* but these flies were not sufficiently abundant to be of any practical importance in the destruction of this pest.

The Codling moth (*Cydia pomonella*) was as usual quite abundant in many orchards last season.

The Bud moth (*Tmetocera ocellana*). Considerable injury was done by this insect during the past season. At the college the larvae were found on apple, plum, cherry and pear, but only the apple suffered sensible injury. The pest was abundant throughout a large part of the province, and in several orchards apple-trees were so badly affected that they assumed a brown parched appearance, owing to the large number of dead leaves and buds in which the bud worms had made their nests. The adult moths were found in the field from June 21st to July 22nd.

Many eggs parasitized by a minute chalcid were found at Ste. Anne's, Como, Baie d'Urfé and Abbottsford. From the pupae were obtained four differents hymenopterous parasites. In spite of these parasites, however, there was a large number of young larvae skeletonizing the leaves in the late summer. Detailed studies of the insect were started last season and will be continued during the coming season.

The second brood of the Pear-tree Slug (Eriocampoides limacina), did considerable injury to plum, amelanchier and cherry. On some plants it was difficult to find any uninjured leaves during the fall.

The Apple Maggot (Rhagoletis pomonella) continues to be a pest at Como, Covey Hill and other places. At Abbottsford I found it in orchards in which it had not been known to occur before, but as it was quite generally spread throughout the orchards it was evident that it had been present for some time, but had been overlooked by the orchardists. In spite of the fact that this insect has bred for years in thorn bushes adjoining the college farm, the college orchard has thus far escaped infection owing to the extremely local habit of the insect.

Mites (Tetranychus, Bryobia, &c.) were very evident throughout the season. Shrubberries and ornamented borders suffered most.

LET US INSTRUCT THE FARMERS

Germain Beaulieu, Ottawa.

People in general, who have never had occasion to become initiated into the mysteries of entomology, can form no idea of the enormous toll taken throughout the world every year by insects on the products of the earth. If any statistics with regard to the matter happen to fall into their hands they content themselves by glancing rapidly over them and shaking their heads as a sign of incredulity. If they are told that the damage caused throughout the entire world by these insects mounts up into millions of dollars; that in the United States alone the cotton boll weevil costs annually $20,000,000 and more; that in a single year the Hessian fly, a very small Diptera that attacks wheat, has caused a loss to the farmers, at the lowest estimate, of $100,000,000, they almost laugh in our faces. To them these figures seem fanciful, and the entomologists visionaries or enthusiasts, like the astronomers.

A little reflection, however, will teach these sceptics to form a better judg-

ment and to place more confidence in those who have devoted themselves to the arduous study of this infinitely numerous multitude of insects. We are all more or less given to judging animals by their size and weights, a little in the same way that we judge of our fellow-men; nevertheless experience constantly teaches us to the contrary. A dog causes us, in general, less terror than a wasp; many people would rather have a robber enter the house than a bat; and I am sure that I had rather endure the fury of a mouse than the hunger of a flea—it is true that I am not a woman! In fact, size is nothing; number is everything: now, the insect has the enormous advantage of numbers. Nothing can resist him, no vegetation, life itself would not be possible upon our planet if the various means of destruction leagued against him did not weaken his powers.

The fecundity of the insect is prodigious; it surpasses anything of which we can conceive. Here is one example from amongst a thousand: the hop plant-louse counts thirteen generations in a year. Let us suppose for an instant that the descendants of one female, only one, were not checked in any way; at the end of a year the descendants of this female would amount to TEN SEXTILLIONS (10,000,000,000,000,000,000,000) of plant lice. Let us now try to form some idea of this fabulous number; the velocity of light will serve us as a comparison. Now, we know that light travels a distance of 186,000 miles a second. Let us suppose now that these ten sextillions of plant lice, each measuring less than 0.0888 of an inch in length, are put end to end in a single line: well, leaving the first aphis, a ray of light would only reach the last one after a period of 2,690 years. That is to say that the string of insects would lose itself beyond the limits that mark the last stars visible through our most powerful telescopes. It is, however, from thousands of millions of millions of individuals that each species is developed. If it were possible throughout the entire world to take a census of the flies, for example, or of the ants, still the numbers that we would obtain would mean nothing to us, because they would be beyond our comprehension; it would be to add to the six naughts of a million a succession of naughts to fill several lines.

But this is only the number of the individuals; there is also the number of the species. The list is an interminable one and is growing still longer from day to day. A collection of 100,000 is not a very large collection compared to the total number of species which inhabit all the great land divisions of the globe. Certain entomologists are of the opinion that the number is over a million. Once complete—so to speak, because the thing is not possible—a catalogue of the species of the province of Quebec would reach, in all probability, twelve millions.

Insects are not all injurious, certainly, but it is with insects as with people: the bad are generally the most active. It takes at least ten virtues to counter-balance a vice; it takes certainly one hundred useful species to counter-balance an injurious species. In spite of the innumerable enemies encountered in all the orders, of animals (mammals, birds, reptiles, insects, microbes) the villainous tent-caterpillar has multiplied in certain years to such an extent as to strip all the trees in a locality; has it not even stopped trains from running on the railroads! I mention here only one species. M. Paul Noel, the learned entomologist who directs the entomological laboratory of the Seine-Inférieur, has catalogued 12,000 species in France alone. If we were to draw up a list of the injurious species which are to be found in our province we should certainly arrive at two or three thousand. The Coleoptera alone would furnish us a list of more than five hun-

dred. No doubt the species are not all dangerous to the same degree, but do not let us forget this,—they can all become so if certain circumstances are favourable to them.

There are not only our own species which we have to fear and to fight against; those of other countries constitute a perpetual menace. Nothing is propagated so easily as an injurious species; there are some that have already invaded the entire world. The importations of plants, grains, fruits, serve as a means of locomotion, when the insect is not propagated by its natural development ; the potato bug has only taken a few years to cover the thousands of miles that separate our province from its native country; three years after its appearance in the United States the Hessian fly was announced in Australia.

There is an incontestable fact which should not be forgotten; that the development of an injurious species in a country is in direct proportion to the development of agriculture. To the two or three thousand dangerous species native to our province have been added several hundreds of other species which have reached us from the four quarters of the globe. It is for us to do our part and to prepare ourselves accordingly. In order to do this it is absolutely necessary for our government to begin to give instruction to our farming classes concerning the scourge of injurious insects; a man forewarned is forearmed, as the saying is, It is necessary therefore that the farmers should be fully warned that the enemy is in their fields, their woods, their gardens, their stables, everywhere; in a word, that on all sides it gnaws, eats, stings, injures and destroys.

The establishment of local stations for the study of insects in the field and for finding the best remedies is more than ever binding upon us. Each species has its habits which are peculiar to it, its mode of life and its method of destruction; further, the habits, mode of life and method of work of members of the same species vary according to the conditions of temperature, humidity, etc. It may be that in a good many cases it will be necessary to operate differently against a species, according to whether it is in the north or south of the province. It is only by experimenting that we can learn this.

The several thousands of dollars that a government invests in such an enterprise are amply compensated for by the benefits that the entire country reaps from it. Ample proof of this can be found in what has been done in the United States, in France, England, Germany, and other countries.

NOTES OF SOME PLANT DISEASES OF 1913

W. P. Fraser, Macdonald College.

The following notes on some plant diseases, that were prevalent on the College farm and the surrounding districts during 1913, may be of interest, especially as most of them have not received much notice in this province.

Downy Mildew of Alfalfa (*Peronospora trifoliorum*).—This disease was not common during 1913. It was probably held in check by the very dry weather that prevailed during the summer. It was very severe the previous season on the first crop of alfalfa but did not appear after the first cutting.

The disease may be recognized by the stunted and contracted appearance of the diseased plants, and the whitish or yellowish colour of the upper leaves. The under side of the discoloured leaves is covered with a grayish or lilac-colored

mold. This consists of the spore-bearing branches and spores of the fungus. The disease may also attack clover, but no collections were made in this region.

No effective measures of control are known, though early cutting of a badly affected crop might be of some value in controlling the disease.

Root and Stem Rot of Alfalfa and Clover (*Sclerotinia trifoliorum*). — During the early summer of 1912 the alfalfa plots on the farm were seriously attacked by this disease. In 1913 the alfalfa was almost free from attack, but the clover grown in the experimental rows suffered severely, a large number of the plants being killed during the fall and the succeeding spring, so that they had in some cases the appearance of being winter-killed.

The plants when attacked by this disease wilt and rapidly die. The top of the root and the base of the stem of the diseased plants will be found to be decayed, the rot extending for some distance up the stem and downwards into the attacked. Later, small black, usually irregular, masses about the size of a pea or smaller may be found attached to the diseased part. Frequenly in clover these are found inside of the root or lower part of the stem, so that they can only be seen by pulling the part to pieces. These black masses are called sclerotia and are masses of the fungus which can live for years in the soil and under favourable conditions start the disease again.

To control the disease the affected plants should be dug out carefully and burned to destroy the selerotia, and the ground sown to grain or grass crops for several years. It is probable that this fungus is not distinct from *Sclerotinia libertiania* which attacks vegetables, particularly in storage. This Sclerotinia rot was common on vegetables in storage during the winter of 1912 and caused much loss, especially of carrots and turnips. It will be found discussed further in the paper on storage rots on another page.

European Apple-tree Canker (*Nectria galligena*). — Specimens of this disease were collected by Mr. P. I. Bryce in an orchard recently purchased by the College. Examination of the orchard showed three trees severely attacked. Although as far as the writer is aware this is the first report of this disease from Quebec, yet it is probably widespread and has been overlooked as the fruiting parts of the fungus are inconspicuous. The old cankers are very conspicuous, but they may have been attributed to other causes.

The disease forms unsightly, deep cankers on the branches and trunks and is also common in the crotches. The disease spreads slowly, the canker growing larger and deeper each year. Curved, septate spores of the Fusarium type are produced in rainy weather during the summer, and in the spring another spore form is produced enclosed in reddish cases or perithecia, which may be found in small clusters in the diseased area. The spores find an entrance through wounds. The disease is a serious one and in some of the apple-growing districts of the Maritime Provinces has done much injury. Measures should be taken to hold the disease in check. The cankers should be carefully cut out well into the healthy tissue, and the wounds disinfected and painted.

Ascochyta Pea Blight (*Ascochyta pisi*). — A few specimens of this disease were collected but it was not troublesome during 1913. The disease causes spots on the leaves and stems, which eventually bear small dark dots, the pycnidia in which the spores are contained. It may also attack the pods and stems and sometimes does serious injury. The disease is doubtless carried over on the seed, so that clean seed from fields free from the disease and rotation of crops will aid in

its control. According to recent investigations the perfect spore form develops on the stem and the scientific name of the fungus becomes *Micosphaerella pinodes.*

Septoria Pea Blight (*Septoria pisi*). — This pea blight was common in some of the plots of peas during the season, attacking especially the leaves.

The effect of the fungus on the pea is similar to the Ascochyta blight, but the spots on the leaves are generally irregular, while those of Ascochyta are usually somewhat rounded. It can be easily separated by the examination of the spores with the microscope, as the spores of Ascochyta are oval and once septate, while those of Septoria are long and harrow and several septate. Control measures are similar to those for Ascochyta.

Blossom-end Rot of Tomato in Well Advanced Stage Showing Characteristic Development. (After Stuckey and Semple).

Millet Smut (*Ustilago panici-miliacei*). — This smut of millet was very serious in the plots of common millet, *Panicum miliaceum,* on the College farm. It has only been reported a few times from North America. The inflorescence of the smutted plants does not expand but becomes a large mass of smut spores enclosed in a sheath. The formalin treatment of the seed will control this disease.

Stripe Disease of Barley (*Helminthosporium gramineum*). — The plots of Mensury barley suffered severely from this disease. It was also present on oats, but did not attack other varieties of barley. The loss in some barley plots must have reached 20 to 30 p.c. The disease causes yellow lines on the leaves and sheaths, which later turn brown. Plants severely attacked do not head, or no grain develops in the head. Spores are produced on the discolored areas. The disease

Raspberry Cane Blight. (After Stewart and Eustace.)

seems to be carried over chiefly by spores clinging to the seed, and formalin treatment of the seed has given good results in controlling the disease.

According to European investigators the fungus develops another spore form on straw that has been exposed to the weather, and on this account should be classed as *Pleospora gramineum.*

Tip-burn of Potato. — The hot dry weather of the season was very favourable for this disease and it was unusually severe.

The symptoms of the disease are the death of the leaves at the margin and tip. The affected part turns dark and the leaves roll up. The disease is due to an insufficient supply of water and hot sunshine. Anything that tends to lower the vitality of the plants, as insect attacks, increases the severity of the disease. Any measures to conserve the moisture or supply moisture to the soil, and the control of insects and fungi by spraying will help to hold the disease in check.

A portion of two diseased Canes affected with Cane-blight

Tomato Blossom-End Rot. — The weather conditions were, also, favourable for this disease, and it was very pervalent. The disease may be recognized by a decay beginning at the blossom and gradually extending over the tomato. The cause of the disease is not known. However, it is not troublesome when the plants are supplied with sufficient moisture. Watering or such measures as will conserve the moisture in the soil will control the disease.

Raspberry Cane Blight (Coniothryrium Fuckelii). — Raspberries suffered

severely from the attacks of this blight during the dry summer weather. The symptoms of the blight are the withering of the leaves and the death of the canes. Usually this is most marked about the time the fruit is beginning to ripen, but may occur earlier. Examination of the diseased canes will usually show the place of attack of the fungus. Here the canes are very brittle and the surface of the bark shows small, dark-coloured, raised dots, the cases which contain the spores. Usually the surface is sooty from the abundant spores exuded from the spore-cases or pycnidia. The wood and pith will be found to be discoloured at the place of attack. The spores readily find an entrance through wounds and infection takes place during the summer and fall but does not usually become evident till next season. Another spore form is produced on the diseased canes in the spring, so the scientific name of the fungus becomes *Leptosphaeria coniothyrium*.

No effective measures of control are known. Cutting out and burning diseased canes and cutting out the old canes as soon as the berries are picked will help to prevent the spread of the disease.

STORAGE ROTS OF POTATOES AND OTHER VEGETABLES

W. P. Fraser, Macdonald College, P. Q.

Frequently potatoes and other vegetables when in storage are attacked by rot and serious losses result. In some cases a wet rot is present, in others the vegetables are attacked by a dry rot, the decaying part usually being covered by a white moldy growth. These rots are caused by either fungi or bacteria. The fungi grow into the tissues of the vegetables and live at the expense of the material stored there. Finally the tissues are broken down and destroyed. If sufficient moisture is present bacteria may also attack the diseased vegetables and reduce them to a wet, ill-smelling mass. Some bacteria may of themselves cause a wet rot without the aid of fungi.

A number of different kinds of fungi cause these rots which may for convenience be included in a few groups. A brief description of these groups may indicate the reason for the methods of control suggested.

1.—*The Late Blight Rot of Potatoes.*—This fungus frequently attacks and kills the foliage during late summer, especially in moist weather. The spores of the fungus fall to the ground, reach and infect the tubers, causing them to decay before they are dug. When stored the rot may develop further and attack healthy potatoes. This fungus is carried over winter in diseased tubers. If these are planted the blight and rot may appear again next season, if the weather conditions are favourable.

2.—*Dry Rots* (*Fusarium Rots*). — These rots are usually caused by fungi which can live in the soil for several years. These fungi may infect potatoes, mangels, turnips and some other vegetables, producing a slow dry rot when they are stored. Generally white moldy tufts are present on the surface of the diseased vegetables. In very moist storage conditions bacteria may invade the diseased parts and bring about a wet rot accompanied by an unpleasant odor.

3.—*Soft Rots* (*Sclerotinia Rots*). — These are also caused by fungi which attack chiefly carrots, turnips and mangels, but do not usually attack potatoes. They are sometimes very serious, spreading rapidly and causing a soft, wet rot without much discoloration of the diseased tissues. These fungi may live for

years in the soil or store-houses by means of black masses of the fungi called sclerotia. These masses may be seen on the surface of the decayed vegetable. Bacteria may also attack healthy vegetables, causing a wet rot with a very unpleasant odor, which is not present in the rots caused by these fungi.

4.—*Black and Blue Mold Rots.* — Sometimes vegetables are infected by fungi such as black mold, often present on stale bread, and the blue mold of bread and preserves. They are serious enemies of stored fruits, but do not generally attack vegetables unless they are injured or weakened in some way. In the latter case serious losses may result.

Control of Storage Rots.—In the case of potatoes select good seed so that no potatoes with a trace of decay may be planted. If possible seed should be used from crops that have not been diseased. Otherwise, the fungi will probably attack the crop and the soil will become infected and unfit for susceptible plants for several years. Use only good plump seed that has not lost vitality or become shrunken from sprouting. Before cutting the potatoes soak them in a solution of formaldehyde (one pint to thirty gallons of water) for two hours—a longer time might injure seed. This will help to prevent dry rots and will also hold scab in check. Spray the potato plants during the growing season with Bordeaux mixture to prevent the late blight rot. In many cases this has been found to increase the yield even if no blight is present.

The following measures will apply to all vegetables:—

1.—Harvest the crop in dry weather and place in a cool, dry cellar or storage. Too much importance cannot be placed on the value of proper storage. The conditions desirable for such are a uniform temperature, as low as possible without danger of injury from frost. Diseases will make little progress if the temperature is kept low, not above 40°F. If the place of storage is too dry the potatoes will shrivel and lose flavour, but this will not be serious if the temperature is low. Cellars under houses are usually too warm and often too dry.

2.—Avoid injury to vegetables in harvesting. Many fungi and bacteria cannot make their way through the unbroken epidemmis, and infection takes place more readily when the epidermis is broken. Diseased vegetables should not be placed in storage as they will probably infect the sound ones.

3.—Clean the storage cellar or house thoroughly, removing all rubbish or decayed matter and burn or bury it so that it will not find its way to the manure pile and in that way reach the land. The walls and floor of the cellar may be washed with a fungicide such as copper sulphate (one pound to ten gallons of water).

4.—Practise crop rotation. Many fungi persist in the soil for several years and if the same crops are grown in the same soil year after year the fungi increase rapidly, whereas if grain or plants, not subject to attack, are grown after vegetables, the fungi will die out.

5.—If rot develops in storage the diseased vegetables should be removed and attention given to the storage conditions.

Attention to these measures of control will not only prevent storage rots to a great extent, but will pay for the time given by the increased yield.

SOME BENEFICIAL HEMIPTERA OF QUEBEC

P. I. Bryce, Macdonald College, P. Q.

Although the order of four-winged sucking insects known as the Hemiptera contains perhaps the most injurious, and numerically by far the worst of our pests, some of the True Bugs are beneficial to the farmer. The benefit is of course indirect, for the value lies in the destruction of noxious insects. Some are only partly predaceous in their habits and feed both on plant and insect juices.

The predaceous bugs show a wide variety of form, which agrees with their diverse habits. Some skip over the surface of ponds and quiet bays, others swim beneath the water, or live far out at sea. Many are marsh dwellers, and lurk in shady spots on the look-out for their unwary fellows. None is more peculiar than the bug which masks its presence with a coating of small particles of dust, while it watches for bed-bugs, flies or other insects. To most of you, however, there are some very much better known. The large slow-moving green bugs sometimes seen on berry bushes, though injurious themselves, have close relatives which are very useful. Several, both useful and destructive forms, similar to the green plant-bug, belong to the Pentatomids or Stink-bugs. They are broad, flat, often with a spine on each side of the mid-region or thorax, and have thicker upper and thinner transparent under wings. On the head are two five-jointed feelers, and between them projects downward a sharp piercing beak, tube-like, and used for sucking plant or animal juices. Many such bugs are protected by evil-smelling and vile-tasting secretions of certain glands. Berry pickers know very well why these are called "Stink-bugs".

Of the few of these malodorous bugs helpful to the plant-grower, Mr. E. P. VanDuzee mentions as occurring in Canada several forms. They feed on a variety of insects, both larvae and adults. While some seem to be general feeders, others more fastidious limit themselves to a few species as food. Several feed in part on insects, and also on plants. In both cases the juices of the host are pumped up through the jointed beak thrust into the tissues attacked. The insect prey is literally sucked dry.

Among the insects fed upon are the Colorado Potato Beetle ("the Potato Bug"), Flea Beetles, Cabbage Worms, Cutworms, Tent-caterpillars, Fall Web-worms, the Eight-Spotted Forester Moth, and the Tamarack Saw-fly. They also feed on the true bugs, on the beneficial Lady-bird Beetles (Lady-bugs), or they may turn cannibal and eat their kind.

Perhaps the most useful Stink-bug is the Perillus (Perillus circumcinctus, and P. bioculatus) which feeds on the Colorado Potato Beetle and other beetles. Both young and old potato bugs are preyed upon, and the young nymphs and the winged adults of Perillus alike help in the destruction. In an account written in 1871 we read that the bug "attacked the Colorado beetle larva with a sudden dart of its sharp-pointed beak and sucked out the contents of the body". Perillus was taken at Montreal, 1902; Ste. Anne's, 1909, and was common in five counties of Ontario where it was collected in 1911. It was there feeding on the eggs, young, and adults of the potato beetles. In some fields of unsprayed potatoes scarcely any beetles were found, because of the activity of the Perillus. The insect is 5-16 in. long, 5-32 in. wide, and easily told by the white margined, brown wedge, the scutellum, which projects back over the wing covers. The general color is

dark shining bronzy-brown, bordered by a creamy-white line which crosses the body between the head and thorax and runs backward down the outer edge of the wing cover, ending on each side near the tip of the abdomen. A similar line but yellower and twice as wide marks the edge of the abdomen beneath, the two lines joining at the tip. The legs are a bright reddish-brown. The young or nymphs are active feeders, and during growth may moult the skin four times, when the perfect winged bugs appear.

Another useful plant bug is a very close relative of the green stink-bug. This clay colored bug (Podisus serieventris) measures about 3-8 inch long by 3-16 in. wide. The upper surface of the body has a very uniform, dull, bug color, varied by the dull reddish triangle at the junction of the opaque and membranous portions of the upper wings. At the tips of the upper wings are two dark brown stripes. The lower surface of the body shows an even, light clay color, with five rows of black dots running lengthwise. The legs, beak and feelers vary from light gray to claret color. The eyes are nearly black. The upper surface of the abdomen proper is marked with black and brown stripes. There is a sharp spine or shoulder on each side, behind the head. The food of this "Under-lined 'Podisus'" shows it to be accountable for numbers of larva of the Promethea moth, Tent-caterpillar, Fall Webworm, the Gipsy Moth in all stages, and several true bugs. Another, the Modest Podisus (Podisus modestus) is so similar to the preceding as to be scarcely told from it, but *modestus* is slightly smaller. The legs are yellow and the general color slightly lighter. Mr. C. E. Olsen says it feeds on the larva of the Maia moth, the Tamarack Saw-fly, the Steel-blue Flea-beetle, and also on the Clematis and Goldenrod.

INSECTS AND THE FOREST

J. M. Swaine, Ottawa.

The forest area of Canada is of vast extent and provides an asset second in importance only to Agriculture. We have been accustomed to look upon our forest resources as inexhaustible; and from the time of the earliest settlers down to the beginning of this century very few gave serious thought to the preservation of the timber. Within recent years, largely through the efforts of the Federal and Provincial Forest Services and the Canadian Forestry Association, the public have begun to realise that our timber supply has been sadly depleted, partly by cutting, but chiefly by great forest fires which have swept enormous areas of forest and killed an incalculable amount of timber. The chief aim of our foresters at present is to obtain control of the fire problem.

It has often been said that the forest has three chief enemies—the fire, the insects and the lumberman. If the forest is thought of as a natural resource, we cannot properly consider the lumberman its enemy unless his methods are unduly wasteful. Our methods of lumbering have been wasteful, in the extreme; but they have improved greatly, and will continue to improve with changing economic conditions. The two greatest enemies of our timber are fire and insects, and in a very real sense the insects do far more damage than the fire. The majority of our fires are ground fires. The trees are killed but not usually destroyed for lumber. Unless a second fire sweeps through, the trees remain standing for many years, and could be out for lumber a generation after the fire had done its work

were it not for the boring insects and the fungi by which they are almost invariably attacked. The insects are the chief agent in the destruction of the timber, and the prevention of fire may be properly considered a method of insect control. In another sense fire and insects may be sometimes directly related. Forest insects, such as certain bark-beetles and the larch saw-fly, kill outright large bodies of timber. It is altogether likely that serious fires at times originate in areas of such dry, insect—killed trees.

The insects which are so injurious to fire-killed timber are adults and the young or larvae of boring beetles belonging mainly to the families Buprestidae, Cerambycidae and Ipidae (Scolytidae). They are often responsible for serious injury to logs and to injured and dying trees wherever found. A considerable number of species attack trees that are apparently in perfect health and are among our most destructive forest and shade tree pests.

The Buprestidae, or Metallic Wood Borers, are large or medium sized, flattened beetles, with bluish black or bronze metallic colours. They deposit their eggs in slits or crevices in the bark during the summer months. The young or grubs excavate, tunnels in the bark and wood. These grubs have the segments immediately behind the head considerably widened and flattened, and have received the appropriate name of Flat-headed Borers. They are very abundant in both hard and soft wood trees. One of the most injurious is the Bronze Birch Borer, *Agrilus anxius*, the worst enemy of our imported cut-leafed birches. The grubs of this species cut long, winding tunnels through the inner bark and sapwood of the trunks and branches of all sizes. The infestation is first apparent from the rusty patches on the bark caused by the overflowing sap from the tunnel being cut beneath. The trees begin to die first at the top. The removal of these dead tops has no beneficial effect, for the borers are by that time working in all parts of the tree. The life of the trees may be prolonged by examining the trees during the fall and spring and removing with a sharp knife the borers working beneath the rusty patches on the bark. All badly infested trees should be cut and completely burned during winter or early spring to destroy the grubs before they can emerge and spread the infestation.

The Cerambycidae, or Long-horned, or Longicorn Beetles, are large, medium-sized, usually cylindric beetles, with long antennae or feelers. Many species breed in the bark and wood of injured and dying trees and logs. The breeding habits are similar to the of the Metallic Wood Borers. Certain species of the Longicorns spend two or three years in the wood as grubs. The grubs are cylindric, with the segments immediately behind the head swollen but not much flattened, and they are known as "round-headed borers". The grubs of most species breed in weakened or dying trees and logs; but certain others cut their tunnels in perfectly sound trees. The Poplar borer, *Saperda calcarata,* is a destructive borer in poplars throughout all parts of Canada. The Locust Borer, *Cyllene robiniae,* excavates its larval tunnels in the wood of Locust trees and Acacias. It is a most destructive pest.

Ipidae (Scolytidae) affect timber in two ways. The true Bark beetles, such as *Dendroctonus, Ips* and *Polygraphus,* cut their tunnels in the inner bark or between the bark and the wood. When they work in living trees the sap flow is checked with fatal results to the trees. They do not penetrate deep into the wood, and consequently do not directly injure the timber. There are destructive species in all our Canadian forests which attack and kill weakened and even healthy trees.

The Eastern Spruce Bark-beetle is the most serious enemy of Spruce in the East, and pines, spruces, balsam and larch are all attacked by destructive species. There are more extensive injuries by these beetles in British Columbia forests. The pines, spruces, balsam, hemlock, larch and Douglas fir are all attacked by destructive species. The bull pine and western white pine have suffered very severely. The trees which are killed by the destructive beetles are attacked by boring beetles of many species and the timber more or less quicqly ruined.

In addition to the true Bark-beetles the Ipidae include the Ambrosia beetles, or Timber-beetles, which excavate small black tunnels into the wood for from less than an inch to nearly a foot. These are common in freshly cut stumps and logs, in weakened trees and fire injured or recently killed timber. They invariably select green wood in which there is abundant sap; but usually prefer trees in a badly weakened or dying condition. Their small black tunnels often seriously reduce the value of logs left out of water during the summer.

The defoliating insects have been much in evidence during the past few years. In Quebec, Ontario, and in British Columbia there have been extensive outbreaks of Tent-caterpillars. Large sections of hard woods have been completely stripped. The work of these caterpillars is over by the first of July, and the trees have considerable opportunity for recuperation during the remainder of the season. It is difficult to estimate the actual injury caused by these outbreaks of tent-caterpillars. The trees usually recover in considerable measure, but the effect of the injury is apparent in the dying branches and unthrifty condition of many of the trees after such attacks. The tent-caterpillar outbreak in Quebec Province was very severe in the season of 1913; but controlling factors were becoming evident in some sections. In the Gatineau Valley immense numbers of the caterpillars died from a wilt-disease just before reaching maturity. As a result doubtless of this high mortality the egg-masses are much less numerous in that district this spring than in the previous two seasons. About Ottawa, however, the egg masses are still very abundant, the moths were attracted by the city lights and have reinfested a section from which the egg-masses were almost entirely removed by hand in the winter of 1912-13.

The Larch Sawfly has spread as far westward as Saskatchewan, and Manitoba larch woods are reported as badly infested, with many trees dying. A serious outbreak appears to be commencing in New Brunswick woods, and has been preceded by an attack of the Larch Case-bearer. The adult sawflies lay their eggs in slits cut along one side of the twigs in spring. The infested leaves become curled and are thus readily distinguished. The caterpillar-like larvae, or young, feed upon the needles and more or less completely strip the trees. Successive defoliations result in the death of the trees. The Case bearer is a very minute caterpillar which feeds on the substance of the leaves through a hole cut in the side. Each caterpillar carries with it a minute case formed of a portion of a leaf which it has hollowed out and a superstructure of silk. The injured leaves die, and more or less defoliation results.

The Spruce Budworm is another well known defoliator. It occurs throughout Canada on Spruces, Hemlock, Balsam, Douglas, Fir and Larch. In the East it is most noticed in Spruce Forests. The caterpillars feed upon the buds and needles of the outer twigs, so that the dead and brown foliage of the outer twigs gives the trees a fire-injured appearance. Usually the trees recover, although attacked two or three years in succession. After three years the parasitic enemies

of the Budworm become sufficiently numerous to control the outbreak; that is, to kill so many of the Budworm caterpillars that the injury ceases.

The Budworm infestations in Quebec Province appear to be dying out in sections from which we have records. In New Brunswick its injury has been very noticeable for the past two seasons. It is always to be feared that Bark beetle outbreaks may follow where the trees are badly weakened by the Budworm attacks; and if any considerable number of spruces actually die, the matter should receive immediate attention.

Our Birches are attacked by several defoliating insects, and of these the Birch Leaf Skeletonizer has been the most recent offender. The adult is a very small moth, with a wing expanse of 3-8 of an inch, bright brown in colour, with the wings crossed by silvery white bars. The young are very small, pale-green caterpillars. They skeletonize the leaves during the late summer, causing the foliage to turn brown. The caterpillars spin round, whitish, silken cocoons, within which they change their skin, and they later construct minute, yellowish, ribbed cocoons within which they pass the winter. These outbreaks seldom last more than three years; for by that time the parasitic enemies become numerous enough to control them.

BEE DISEASES

With Special Reference to European Foul Brood.

F. W. L. Sladen, Apiculturist, Central Exp. Farm, Ottawa.

Bee diseases may be divided into two classes, those affecting the adult bee, the commonest being dysentery, and those affecting the bee larva, the best known being foul brood, of which there are two kinds, American foul brood and European foul brood. On account of its highly infectious and rapidly spreading nature, and the fact that it kills the larvae that are stricken with it, foul brood is a very destructive disease, and requires energetic treatment. This is especially the case with European foul brood, which is causing great loss in a wide and ever-extending area in the Southern part of the province of Quebec. In a colony affected with European foul brood the bee larvae, many or few, are seen to have fallen into an irregular melting mass, lying in the bottom or on the lower side of their cells. This mass turns to a dull yellowish or grayish colour, growing darker later as it begins to dry up. In badly affected colonies a sour or putrid odour is noticeable.

European foul brood may be distinguished from American foul brood by the fact that the rotting mass cannot be drawn out into strings on inserting a match or tooth-pick into it, and also because it attacks most of the larvae in a somewhat earlier stage, namely before they are capped. There are, therefore, few sunken and perforated cappings, so characteristic a feature of American foul brood. European foul brood is especially destructive in early summer; in late summer it may almost disappear, but it will re-appear with full virulence the following May or early in June. It spreads more rapidly than American foul brood, and it is almost impossible to stamp it out of a district that has become thoroughly infected with it.

Both diseases are due to bacteria which are conveyed mainly in the honey,

though they are present also in the hives, on the bees, etc. The initial treatment of both diseases is the same. It is based on the removal and destruction of all infected matter. The bees should be shaken into a clean hive containing frames fitted with inch-wide starters of foundation, the old combs melted down (boiling for an hour destroys the bacteria), and the old hives thoroughly disinfected by scorching. A good way to disinfect the hives is to tier them, one on top of another, and place at the bottom of the chimney so formed a heap of straw or excelsior on which a little kerosene or gasoline is poured; then light the straw, and after the flames have thoroughly scorched the inside of the hives, they should be extinguished by placing a cover on top of the hives.

The black bee is very susceptible to European foul brood, but the Italian bee is more or less resistant. In an apiary where this disease has occurred it is, therefore, important to requeen the colonies with Italian queens. Each year after this is done queens and drones may be bred from the colonies that have proved most resistant to the disease, Blacks and Italians are equally susceptible to American foul brood.

The greater part of Eastern Quebec appears to be still free from European foul brood. It is, therefore, important that bees should not be imported into this region from regions that are known to be infected, without a guarantee that the apiary from which they come is entirely free from the disease.

NOTES ON THE LIFE HISTORY AND CONTROL OF THE BEE-MOTH OR WAX WORM

By J. I. Beaulne, Ottawa.

A serious hindrance to the keeping of bees in Quebec, as well as in the other provinces of Canada, is the bee-moth (Galleria mellonella). Under the name of wax-worm, this pest is known to every up-to-date bee keeper; but it is not generally known that these wax-worms develop into moths or "millers". The larvae or caterpillars feed upon stored comb and honey, as well as combs in the hive occupied by bees, makes it a difficult pest to fight with success.

When and how this pest was introduced into Quebec is not known, nor have we any notes on the location of the first infestation. It is very evident that the dissemination has been complete, for there are but few places where bees are kept that are free from this pest.

What the wax-worm is costing the bee industry of the province is hard to determine, the value of bees, honey and wax varying very much in the different localities. Often the loss of colonies is attributed to other causes, and very often the presence of the bee moth is not detected.

The adult bee-moth is about 5-8 of an inch in length. The moth when at rest appears ashy gray in colour, but the posterior third of each front wing is bronze-colored, and this wing is thickly covered with fine scales which rub off easily when the moth is touched. The body is brown, the shade varying, with a covering of scales. The male is slightly smaller than the female.

The moths emerge entirely at night. They seek at once some protected place in which to expand their wings and dry, and by the next eight or ten hours they are able to fly about. The male moths emerge a few days earlier than the females, and are much longer lived. The moths mate at night, very soon after their emer-

gence, and five or six days after the mating the female moth begins to oviposit.

The egg is elliptical, measuring about 1-50 of an inch in length and in .43 mm. in width. The shell is pearly white in color and slightly roughened. Throughout the embryonic development the egg gradually changes from a white to a yellow-color. About 3 or 4 days before hatching the developing larva becomes visible inside the shell. After it is out of the shell it appears white and clear. After the larvae have emerged from the eggs, they are usually quiet for a short time. Soon they become active, and upon close examination they will be found crawling over the combs in an attempt to find an entrance before they are detected by the bees. The entrance is made at the top of the cell-wall between the cells. When the center of the comb is reached, the larvae leave their tunnels and wander over the bottom of the empty cells, or in the case of combs containing honey or pollen, they tunnel along the midrib from cell to cell. If they are disturbed, they seek their tunnels, which they re-enter for protection against their enemies. After the midrib has been destroyed, the larvae begin to work on the walls of the cells, the ones farthest from the light being the first to be destroyed. Soon the center of the combs begins to appear as a solid mass of tangled refuse, discarded wax, and silk cocoons.

After the larvae have completed their growth, they seek a place where they can pupate in safety; sometimes the ends of the feeding galleries may be slightly enlarged and closed in to serve as a cocoon. The cocoon may be spun in the refuse under the comb, between the combs and the walls of the hive, or in any crevices near at hand.

Sometimes the larvae seek to enter in a tight place where they can chew, in order to construct a cavity, and pupate with better protecion.

At any time from early spring to the middle of October the examination of a colony is likely to reveal this insect in all its stages. In protected hives the developing stages may continue the whole year without interruption. Usually the winter is passed with one-third of the insects in the pupal stage, and the remainder in the larval stage.

The maximum number of moths which mature from the over-wintering larvae and pupae appear about the 15 of April to the 15 of May. The moths are very active, and soon after mating they begin oviposition. Usually 12 days are required for the eggs of this brood to hatch. It will be seen by this that it does not take very much time to have a colony of bees infested with this pest in its larval stage.

Of the natural enemies of the bee-moth, the most important and most reliable, is the honey-bee itself.

In the absence of any other natural enemies of importance, the measure of artificial control must be made all the more effective if the bee-keeper is to free his apiary from the pest.

One of the best methods of artificial control, and one upon which the majority of bee-keepers depend, is the fumigation of combs and honey. The gas is able to penetrate material, that it is not possible to treat in any other way.

Among fumigators used to treat the combs infested with the larvae of the bee moth are the following, which are very effective.

(1) Sulphur, which is used by many bee-keepers because it is cheap and does not require so much care as other fumigators or disinfectants in use.

(2) Carbon bisulphide. In evaporating the bisulphide gives off fumes that

are very effective against the larvae of the bee-moths. No fire should be allowed where it is going to be used or serious consequences may result.

How to fumigate with Sulphur.

A pan full of wood ashes is placed in a little tin vessel into an empty super on the ground. The sulphur is then put on the ashes, and the hives containing the empty combs are placed in a stack over this empty super. Afterwards the cover is placed on this stack of hives. The whole thing is left alone for about 15 minutes during which time the fumes of the sulphur will penetrate everywhere, and kill all the living larvae of the bee-moths. A very small percentage of the eggs will be rendered useless.

How to fumigate with Carbon Bisulphide.

The fumes of the bisulphide, being heavier than air, penetrate through every possible opening and destroy every living thing. It is far ahead of the old fashioned sulphur for combs infested with the larvae of the bee-moth, because it is handier, quicker, and surer. The work of preparing the hives does not endanger the bee-keeper's life, as it is easily and rapidly done. Care must always be exercised in the use of bisulphide of carbon, as it is highly inflammable and should therefore be kept away from any fire. The inveterate smokers among bee-keepers should put his pipe or cigar, or cigarettes far away, at least 50 yards from where he is going to use this fumigator.

The hives containing the empty combs in whichit is feared there are a few larvae of the bee-moth are piled in a stack, or as it is convenient, and all cracks between the supers or hive bodies made as nearly gas proof as possible. A tight cover should already have been placed at the bottom of this stack. The empty super is then placed on top of the stack of hives, and the vessel containing the bisulphide is placed inside. The next thing to do is to place a tight fitting cover over the super on top of the stack.

Here is another way of operating out-doors:

At first a small trench is dug in the ground, into which is placed a large newspaper, and then the stack of hives is piled on this. In the top hive-body is placed a saucer containing some carbon bisulphide and then this is covered with a newspaper. Then over the whole stack is thrown a heavy-cloth, and the water poured over it until it is thoroughly wet, and lastly covered with a large wagon cover or sheet, and left for some time. Carbon bisulphide is obtainable from practically every druggist.

A BACTERIAL SOFT ROT OF TURNIPS

F. C. Harrison and W. Sadler.

Bacteriological Laboratory, Macdonald College, P. Q.

Occurring more or less frequently according to season and varying in destructiveness with the meteorological conditions, the so-called "Soft-Rot" of such vegetables as turnips, carrots, cauliflowers and cabbages is the cause of serious-

economic losses to farmers and vegetable growers, and hence has attracted the attention of numerous investigators to the disease and the organisms producing it.

As a résumé of the literature has been recently published it seems unnecessary to give any extensive citations. Suffice it to say that M. C. Potter[2], L. R. Jones[1], A. Spieckermann[3], C. J. J. Van Hall[6], F. C. Harrison[5], H. A. Harding and W. J. Morse[7], and F. C. Stewart[8] have described with considerable detail the action of various organisms associated with the soft rots of some of the fleshy vegetables. From the practical standpoint it is sufficient for the grower to understand that the disease is caused by a bacterial micro-organism, but from the point of view of the biologist there is considerable interest in defining as closely as may be the relationship of the various organisms isolated and described by investigators who have worked on the disease as it occurred in the field and on the various vegetables attacked.

As a rule, organisms associated with a well defined disease are recognized with a certain degree of ease, but in the case of the 'soft rot' organisms there seems to be no end to the making of species and varieties, and lest we should be accused of the itch of species making, let us state that the present study was undertaken in order to attempt to find out some facts in connection with the relationship of these bacteria with a view of establishing a type, and, the proof of the pathogenic nature of the organism in turnips.

Harding and Morse[7] have attempted to minimise the number of species by bringing these organisms into a few main groups and by describing their cultures by a plus or minus reaction in certain media, and using decimal numbers for the description of each combination. This system, however, ignores the relation of the organism to its host plant, and obscures the natural phylogenetic relationship of bacteria types, nevertheless such an effort is of great use in routine description, and for arranging and cataloguing cultures.

In the present study we have worked out in detail the pathogenicity of an organism belonging to the 'soft rot' type, which was the cause of a rotting disease in turnips, and have described its morphological and cultural features in detail. Several important peculiarities have been noticed, and as far as possible these have been photographed.

Our attention was first directed to this disease by Mr. Paul A. Boving, B.A., B.S.A., assistant in the cereal husbandry department of Macdonald College, and in charge of all the root experiments. Mr. Boving has contributed the field notes of the disease, and has given a number of excellent photographs of the naturally occurring disease, one of which, Fig. 12, is reproduced.

Field Notes on the Disease.

The disease was observed during the first week of September, 1912, and the outbreak continued until the end of October, when all roots were pulled and the diseased ones thrown aside. The percentage of diseased plants is shown in the following table:—

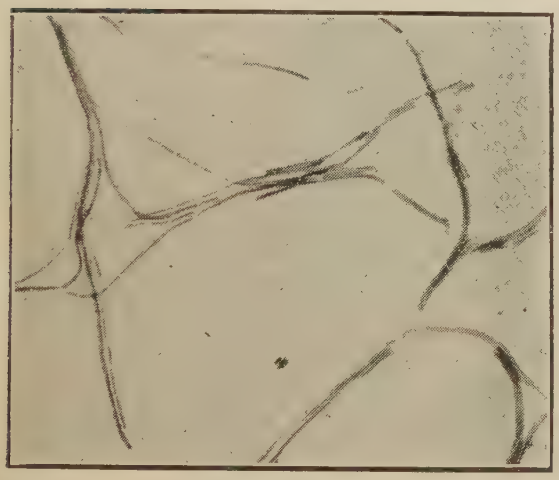
Per cent. diseased plants in turnips of different classes during 1912:

6	varieties	globe-shaped,	white	fleshed	12.0%
4	"	long "	"	"	8.5%
4	"	globe "	yellow	"	13.7%
7	"	long "	"	"	5.%
				Average	5.9%

From this it would appear as if the long-shaped, yellow fleshed were more resistant against the disease than the others. If, however, the figures for the duplicate plots of this class are examined more closely, we find in some cases a greater difference between two plots of the same variety than between any two classes compared with each other.

Per cent. diseased plants in the long-shaped, yellow-fleshed class of turnips, 1912.

		A-plots	B-plots
Yellow Tankard, Pajbjerg 2	(Helweg)	4.9 %	1.4 %
" " "	(Faber)	4.1 %	8.4 %
" " "	(S. F. A)	0.7 %	2.1 %
Bortfelder	(W.)	2.1 %	13.7 %
"	(A. D. C. S.)	6.2 %	10.0 %
"	(S. F. A.)	2.8 %	9.0 %
"	(Sv.)	0.7 %	9.3 %
	Average	3. 07%	7.74%



1.—Turnip Rot bacillus from culture on Potato agar 15 hours at 37° C. x 1000

2.—Turnip Rot bacillus from culture on beef peptomine agar 16 hours at 30°C. Van Ermegen's method. x 1000.

Both Yellow Tankard (S.F.A.) and Bortfelder (Sv.) show only 0.7 per cent. diseased roots in the A series. In the B series, again, the Yellow Tankard strain still has a comparatively low figure, or 2.1 per cent. diseased roots, but the Bortfelder strain has been badly attacked in this part of the field, showing 9.3 per cent. diseased roots. The B plots in general suffered more from the disease than the A plots.

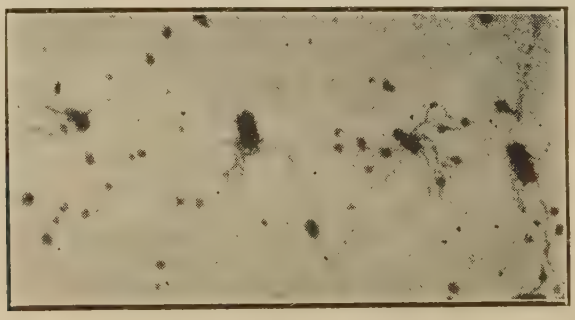
Although all classes were more or less attacked in different parts of the field, the figures seem to indicate that the long-shaped turnips in general possess a slightly higher power of resistance than the globe-shaped. This may perhaps be accounted for by the circumstance that the relative proportion of 'true root' or primary root is higher in the long-shaped turnips, whereas the 'hypocotyl' dominates in the globe-shaped varieties. There is at least an indication that the

hypocotyl part of the root is less resistant against the disease than the true or primary part of the root. Thus the lower part (the true or primary root) of a long-shaped turnip which has been attacked by the soft rot is still sound in many cases, but a globe-shaped turnip (mainly consisting of hypocotyl) is generally entirely destroyed.

The outside bast layer of the turnip withstands the attack fairly well, and instances were found when an outwardly sound root was absolutely hollow inside of a thin layer of skin and bast. Another feature worth mentioning is that the crown very often keeps green even after the greater part of the inside root has been destroyed.

3.—Turnip Rot bacillus from culture on beef peptone agar, 15 hours at 30° C x 1000.

The infection seems to spread from the pith of the root and often starts from the middle of the hypocotyl. How the organisms gain entrance to these deep tissues has not been demonstrated experimentally.



4.—Same preparation as Fig. 2 x 2000.

Whilst the rot appears in dry as well as wet years, the seasons 1910 and 1912, which may be described as *wet* years were characterised by much soft rot. On a rough estimate, 40 per cent. of the turnips in 1910 were diseased. The conditions of the trial plots on the College farm were similar to those found on farms throughout the country, and we have received many reports of the prevalence and destructiveness of this rot from Quebec and Ontario.

Signs of the Naturally Occurring Disease.

Early manifestations of the disease are rare. In an advanced stage the leaves wilt, hang down, dry and wither. The rotted material at times breaks through the skin, giving rise to a very distinctive and putrid smell. The natural turnip odour seems to be exaggerated to offensiveness. In many cases the root looks sound on the outside, and the crown of leaves is erect and healthy looking, but a smart tap of the foot will cause the collapse of the turnip, and the interior will be found to be composed of a soft, pulpy dark mass. In such cases the leaves evidently obtain their supplies by the *last* ring, which is not diseased.

Isolation from naturally infected plants was easily carried out in ordinary media. The rotted portion of infected turnip was crowded with an organism practically in pure culture, and high dilutions were necessary in order to obtain discrete colonies. After isolation from the initial set of plates, the organism was again plated and replated.

After working out the morphology and cultural characteristics, a series of growing turnip plants was inoculated. These plants were grown under glass. The soil used was from rotted turf and sand.

Experiments with Growing Plants.

In the first trial, the crown of a turnip plant was punctured with a sterile needle and then the inoculation was made with material from a young agar culture.

5.—Turnip Rot organism from B. P. agar at 30° C. x 1000

Two days later the point at which the inoculation had been made showed an exudation of liquid to such an extent as to leave no doubt of the disease producing power of the culture.

One week later the plant showed signs of having the disease badly; the stem supporting the leaves was almost fallen away from the root, needing only the slightest pull to bring that about. The leaves had withered and the plant had a dying appearance.

6.—Turnip Organism from Potato agar at 37° C x 520.

On being cut up the turnip had the typical appearance of the original disease; from the crown downwards to half the depth of the root was completely rotted, except that the shell of the root remained sound.

Microscopic examination of the diseased portion showed the organism in large numbers and evidently pure. Plate cultures were made from the diseased part of the root and the organism re-isolated was in all respects identical with the one originally isolated.

In a second series of inoculations the root itself was inoculated with organisms from a young agar culture by means of a needle puncture.

After the same interval had elapsed as noted above an examination was made. The appearance of the top part of the plant differed very much from the appearance noted in trial I. The leaves appeared quite normal and, to the eye, the root also seemed to be quite sound. On the root being cut open, the whole of the centre of the turnip was rotted, the disease having in every respect the typical characteristics.

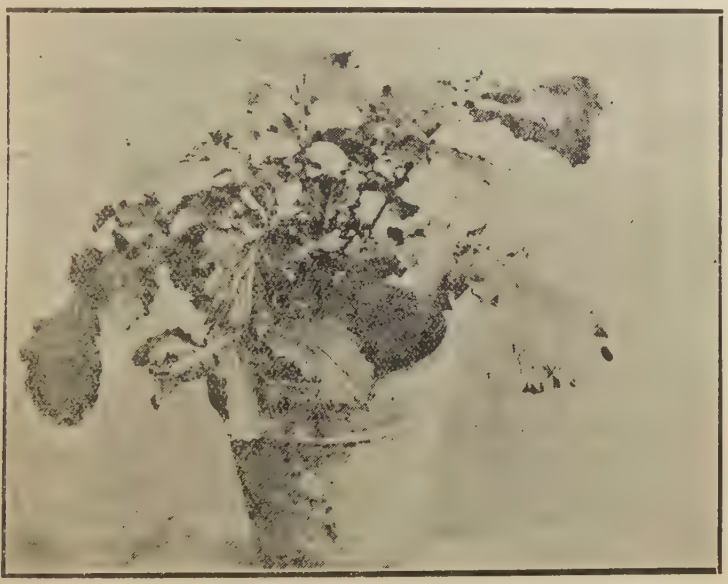
Both microscopic examination and replating on gelatine plates and other media, yielded results which proved beyond doubt that the artificially produced disease was identical with the original.

It is of interest to note at this point that turnip may be badly diseased and yet the appearance of the leaves and stem be such, that any other than a careful

ocular examination will fail to discern any symptoms until the root is pulled or lifted.

This condition, produced and noted experimentally, is quite usual in the field, and is shown well by Fig. 12.

In both these trials the control plants which had been pierced with a sterile needle did not show any sign of disease. The specimens obtained experimentally, in addition to roots which had become naturally infected in the field have been successfully preserved for museum purposes in a 10 per cent. solution of 40 per cent. formaldehyde.



7.—Healty Turnip plant.

At a later date, further trials were made with growing plants, inoculations being made from young agar cultures of the organism reisolated from the artificially produced disease described immédiately above.

Fig. 7 is a photograph of one of the healthy turnip plants with which these trials were carried out. Inoculations were made in the crown of the turnip, caused a rapid production of the disease, and in five days the condition as shown in Fig. 8 was obtained.

The leaves had drooped and withered to such an extent that they hung over the side of the pot, and the root was so badly rotted that it could not be lifted out of the soil.

Fig. 9 represents a turnip which had been inoculated on the same day as the one just described. In this case the inoculation was made by needle puncture in the root, and twelve days later when the photograph was taken the leaves were all withered and partially rotted, while the root was completely rotten.

Fig. 13 is a photograph of a turnip which had been inoculated by needle

puncture in the crown, and while in 12 days time it looked apparently healthy, sufficient evidence had already accumulated to show that the condition of the leaves may not necessarily be a guide as to the soundness of the root.

When this photograph had been taken ,the turnip was cut in two and the rotted condition as shown by Fig. 14 was made evident.

Replating on gelatin from these rotted turnips invariably yielded an organism identical in all respects with the original culture.

In Fig. 10 is a photograph of a healthy cauliflower which was subsequently inoculated by needle puncture in the heart and in the stem with the turnip organism.

8.—Turnip plant inoculated in crowu with culture isolated from diseased turnip produced in laboratory. 5 days after inoculation.

In 14 days time the heart of the vegetable had rotted to a considerable extent, while the effect on the stem had been such that several leaves had died and fallen off, as shown in Fig. 11.

While we anticipate a continuance of these inoculation trials in growing plants, as the different varieties are available in season, we recognise that the practical application centres ahound the effect on the soil after a crop of turnips infected with this disease has been disposed of.

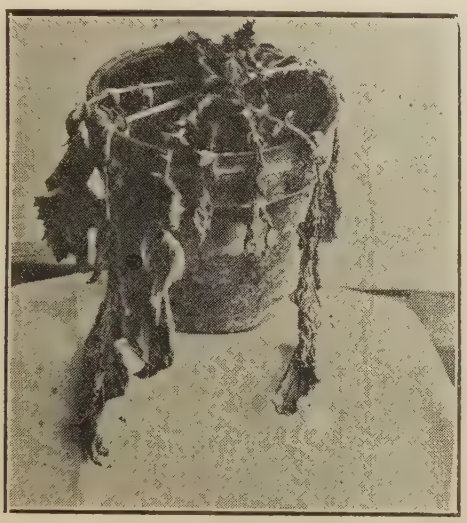
In view of this, as a preliminary trial, we prepared a series of pots with soil, and steri'ized them in steam under pressure for three hours. A strong culture of the organism was grown in beef bouillon, and, the maximum growth having been obtained, we mixed with the culture a proportionate amount of a synthetic medium—Uschinsky's.

With this mixture the soil in one of series pots was treated.

The soil in the control series of pots was treated with a mixture of sterile beef bouillon and Uschinsky's medium.

In each of the pots, control and contaminated, an equal number of turnip seeds was carefully sown, and from that time onward the whole of the series watered with sterile water.

In ten days' time the plantlets were considered to have attained a suitable size for demonstration, and they were accordingly photographed as shown in figure 15.



9.—Turnip plant inoculated in root with culture obtained as for Fig. 8. (12 days after inoculation.

Pots II and IV contained contaminated soil, Pots I and III being the control.

There is sufficient evidence in the results of this preliminary trial to warrant further investigation along these lines, particularly n vew of the economic importance of this phase of the question.

Experiments with Fresh Vegetables.

A large variety of fresh vegetables were cleaned, dried and then cut with sterilised knives in slices of an average thickness of ¾-1 inch, placed in sterilised Esmarch dishes and inoculated with one else of material from an agar culture.

The results briefly noted are as follows:—

Red Carrot. Softening and water-soaked appearance in 24 hours; in a week, rotted through and centre quite black; a few days later, rotting complete and slimy.

White Carrot. In 24 hours softening beginning, with water-soaked appearance; vascular circle brownish; action much the same as on red carrot, except that the centre becomes dirty white and not black.

Potato. Very rapid action; in 24 hours a soft creamy looking growth closely resembling sputum. Potato completely softened.

Turnip (White). In 24 hours considerable growth and softening to a depth of 5-6 mms. In 96 hours the softening increases to a depth of 1 1-2 cms., the turnip having a dirty white appearanve.

Beet. Growth on surface, but no softening.

Swede Turnip. In 48 hours typical softening with water soaked appearance; 24 hours later large beads of moisture on the surface; rotting much increased, and the development of a smoky black color.

Cabbage. In 24 hours abundant growth; considerable softening and waterlogged appearance. In 96 hours the stem much rotted and leaves reduced to a soft pulpy mass.

11.—Cauliflower 14 days after inoculation with Turnip organism in crown and stem.

Artichoke (Jerusalem). In 24 hours rapid growth, with softening and black appearance of diseased portion.

Mangold. Very slight growth on surface, and no softening.

Sugar Mangold. Very slight growth on surface and no softening.

Sugar Beet. No softening.

Parsnip.—In 24 hours softening commences with whitish growth. In 96 hours the softening has increased to a depth of 1 1-2 cms., the growth later assuming a brownish and finally a decidedly black tint.

Celery. Rapid softening, and in 48 hours almost entirely rotted; the color is dirty white and whitish appearance on the surface.

Cucumber. Very rapid softening and exuding of milky looking fluid on the top. In 24 hours the softening reached a depth of 1 cm. and extended over the

entire surface. In less than a week the slice of cucumber is entirely reduced with an objectionable odor and a yellowish colour.

Tomato (Green). Rapid softening, but not quite so complete as in the cucumber; in 24 hours a depth is reached of 1-2 to 1 cm.

The rotted tomato assumes a deep grey colour, and a dark brown liquid exudes.

Hubbard, Crook Neck and Winter Squash. These varieties of squash have been inoculated and in each case perceptible softening occurs within 24 hours. In 96 hours this has increased to the extent of 2 1-2 cm. in depth.

10.—Healthy cautiflower plant.

Onion. Rapid and complete rotting; the onion has a yellowish white appearance and a vile putrid odour.

Lettuce. In 48 hours the heart of the lettuce is completely rotted.

Sweet Potato. The organism has a very rapid effect. In 12 hours, at 25-30° C, the potato assumes a yellowish appearance at the point of inoculation and softening has progressed to the extent of 1 mm. A very strong and agreeable smell or perfume resembling oil of citronella is perceptible.

In 24 hours the yellow appearance has deepened to a dirty white and the softening has increased to a depth of 2-3 mms., while the odour has become much more pronounced.

Radish. In 24 hours there is softening of both stem and foliage, and in 48 hours a young radish is completely rotted, with a distinctly objectionable and putrid odour.

Banana. In 24 hours growth and softening: in 48 hours pieces of banana 3-4 inch thick completely rotted with a waxy appearance and formation of gas.

Rhubarb. Whitish growth on surface, but no softening in 24 hours.

Asparagus. Brown stain on all cut surfaces, no softening in 24 hours.

The media used in the cultural work consisted of—

Beef peptone gelatine,
" " agar,
Potato gelatine, and
" agar.

12.—Diseased Turnip Plant obtained direct from field.

In preparing the two former, the standard methods of the American Society of Bacteriologists were adhered to, the reaction to phenolphthalein being adjusted to 1.5 p.c. acidity.

To obtain the latter, healthy sound potatoes were grated and the juice thus obtained strained through fine cloth and at once heated for half an hour in the steamer at 100°C. After standing for a few hours a comparatively clear liquid was obtainable. This poured off constituted with the addition of 5 p.c. of Natirstoff Heyden and 12.5 p.c. gelatin or 1.5 p.c. agar the potato media.

The media was cleared in the usual way, and after adjusting the reaction to 1.5 p.c. acidity (phenolphthalein) sterilisation was accomplished by intermittent heating for three successive days.

13.—Turnip plant 12 days after inoculation with turnip organism in crown.

14.—Same turnip as Fig. 13 cut in half.

A medium was prepared from healthy turnips by methods similar to those adopted with the potato medium; the results, however, were not such as to make the using of turnips of any advantage.

15.—Turnip seeds sown in contaminated and uncontaminated soil. Pots II & IV contaminated.

In testing for the percentage of gas present, a gasometer chart was used and the amount of gas expressed in per cent. of the total volume of the closed arm of the fermentation tube.

All sugar tests have been done in quadruplicate, and all other cultures made in duplicate, and in many cases in quadruplicate.

(Note.—Other plants were inoculated and some reacted. A list of these plants as well as technical details regarding the morphological characters of the organism and the preparation of culture media will be found in the Transactions of the Royal Society of Canada, 1913).

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INJURY AND ABSCISSION IN IMPATIENS SULTANI

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It is a well-known fact that the injury to developing fruits by insects is followed by shedding, and the same is true of flower buds. Perhaps the most notable example, historically considered, is the shedding of cotton flower-buds and bolls as the result of the punctures made by the boll-weevil (Anthonomus grandis), this because of the dramatic progress of the insect across a wide territory year by year, moving, like a tidal wave, inexorably and unhinderably. Other examples, however, are numerous enough, and will be called to mind by everyone familiar with the crops of fruit-garden and orchard.

Obvious, however, as this fact is, it is by no means a simple physiological problem. Even the amount, position and kind of injury necessary to procure a definite response are not yet known, quite apart from the events in the sequence of changes initiated by the mechanical act of injury, though in the case of pears and of allied fruits probably, injury is followed by the rapid formation of tannic acid in the injured parts (Cook et al). There has, nevertheless, been some attempt at determining the amount and kind of injury required to induce abscission in a

few instances, and I have alluded to these in a paper in press. At the time this was in final revision, an additional brief article on "An axial abscission of Impatiens Sultani as the result of traumatic stimuli", by R. A. Gortner and J. Arthur Harris appeared (3). In it these authors report some inquiry into the effect of injury on, and the method of, abscission of the stem in *Impatiens Sultani,* and convey the impression that the phenomenon of axial abscission is a rare, or at any rate practically unstudied, phenomenon. Though less rare than unstudied, it has nevertheless received considerable attention. Instances have been studied by Correns (4) in the mosses by vonHoehnel (5), Vochting (6), Massart (7), Loewi (8) and Hannig (9).

The pertinence of a comparison of the phenomenon in the mosses and higher plants I have indicated in my paper above cited. VonHoehnel's work on abscission in twigs, though meagre, is sufficient to indicate that, so far as the living tissues are concerned, the process in twigs is not different from that in many leaves, and this is borne out both by Loewi's work and by my own. Employing experimental means (injury), Loewi found that the amputation of the internode (in *Euonymus*) is followed by abscission at its base, accompanied by a more or less extended oedematous development in neighboring tissues. Vochting observed the shedding of internodes after amputation in *Heterocentrum* and *Begonia,* while Massart saw the same in *Impatiens Sultani.* Massart was, however, certainly wrong in saying that injury is not followed by the formation of wound tissue except below the abscission layer, and Hannig is also not in the right when he criticises Massart, maintaining that the latter was probably wrong in not regarding the cell division near the separation layer as belonging to the abscission tissues. From my own observations I am satisfied that cell-divisions take no part in abscission in this plant, and that those seen by Massart are indeed an expression of wound activity following separation.

Hannig, working with peduncles and internodes, found that he could induce their abscission by trans-section sufficient to cause material reduction of the water supply, or by complete amputation, but that injury, no matter how extensive, is not in itself efficient, and this I am able to confirm. *Ampelopsis* is to be numbered among those plants which shed their internodes and tendrils both normally at the close of the growing season, and under experimental conditions, while cotton (*Gossypium*) bolls are readily caused to shed by certain kinds of injury. Abscission of these parts may be induced by amputation, but severe injury to the vascular supply *below* their insertions was found by me to be ineffective, although their water supply must have been interfered with.

Being primarily concerned with the method of abscission, I have re-examined *Impatiens Sultani* for comparison with some thirty-odd other species already studied, since a delicate and succulent plant such as this offers especially good material for the more critical examination of certain details bearing on this question. Incidentally, however, some facts have been gained which should be mentioned as bearing on the phase of the problem more especially considered by Massart and recently by Gortner and Harris.

If an internode be cut off anywhere along its length, abscission will follow either near to and above its base, or in a similar position in any internode below, if leaves are absent. The farthest removed internode in which I have found it to occur without the abscission of any of the intervening ones is the seventh. On the other hand, it may take place in all the internodes at once, or successively.

This various behaviour appears to be connected with the condition of the axillary buds as suggested by Gortner and Harris. In spite of the presence of small leaves (a few mm. long), unless the buds are able to develope promptly or if they are wilted badly and unable to recover, several internodes are shed in one piece whether injury has been made use of or not. Whether therefore what remains of an injured internode only falls, or one or more additional internodes are shed at once, depends, as Hannig showed in the case of the leaf, on the presence or absence of a minimum amount of leaf surface, since small entire leaves may not be sufficient to prevent abscission.

Gortner and Harris found it difficult to decide how near to the future abscission layer the cut which induces it could be made, and still be followed by it, since the cut surface dried up, and since it was difficult to tell whether a thin layer of cells has been separated off by abscission or not. I find that, if the surrounding air be kept moist enough to prevent drying out, abscission intersects may occur within a mm. of the cut, or, if the plane of future abscission intersects that of the injury, the abscission will proceed to intersect it actually. It would seem that the position of the cut has little, if any, influence on the position of the abscission layer, so that normally, if the cut is made below it in position, abscission of the low stump that is left will not occur. Inasmuch as the abscission layer is frequently very oblique, it would be difficult to make a cut quite near to the base of the internode which would certainly prevent abscission in all cases, or even in many.

However, the case of superimposed abscission layers, presently to be described, together with some other cases of injury by amputation in different positions, suggests caution in deriving any strict conclusion, for in these instances the abscission layer may have occurred higher up than normally, and indeed seems to me to have done so. One case is worth mentioning. The cut was made about 1 mm. above an axillary bud and somewhat obliquely, and the abscission layer which was subsequently formed intersected the plane of amputation as indicated in figure 1a-c. I found however that instead of passing through the pith at the expected position, the abscission layer skirted around the stele. In this instance the operation appears to have modified the position of the abscission layer.

It may happen (I have observed it in one instance) that two superimposed abscission layers may be formed, the upper first, the lower appearing 2-3 mm. below it (figure 2). This recalls the case of the leaf of *Hamamelis* observed by Tison (10), in which however the behaviour is normal, the second abscission ensuing in the early spring. So far as I am aware this behaviour has not been observed in other plants, but will doubtless occur occasionally.

Still more unexpected, but more frequently to be seen, is the abscission of the leaf base and its accompanying axillary bud, and which I shall call lateral axial abscission. It is quite distinct from true leaf abscission, since it occurs after the leaf has been shed, and lies wholly within the stem tissues with the exception noted below. The abscission layer is approximately hemispherical, the curve passing through the vascular tissues of the stem and penetrating as far as the center of the pith (figure 3-b). It enters the stem a short distance above the axillary bud, and comes out in a similar position below the leaf base, but may occasionally pass through it (figure 3d), as shown in the figure. With respect to the leaf base the abscission layer is then almost longitudinal. This kind of abscission may occur also in conjunction with transverse abscission, the two being confluent (figures 3a-b);

but it may occur quite independently. I have seen a half-dozen instances, but only in plants kept in a moist chamber. In all instance the buds remained undeveloped, though in otherwise normal condition. No evidence can be clearer than this to show that the position of the abscission layer is determined physiologically.

Gortner and Harris observe that injury of an internode by insects is an efficient cause, as no doubt it may be. But to what extent, and what the nature of this injury must, as I have said, still be inquired into. Hannig (9) found it impossible to cause shedding (of peduncles or internodes) by any kind or degree of wounding so long as enough vascular tissue was left to insure the necessary quantum of water and nutrition. The lack of the latter is doubtfully the direct cause in any event, since he observed an abundance of starch and a healthy appearance when abscission did intervene.

These results are generally true also of *Impatiens sultani*. I did the following experiments.

1. Longitudinal cuts were made from one end to the other of long internodes. In one case the cuts were made so deeply that, as the result of callus formation, the wounds gaped widely enough to allow one to see through the stem. Sometimes sectors extending throughout the internode were removed. In no case did abscission follow.

2. Transverse cuts were made so as to trans-sect all the vascular tissue of the internode at one point or another, without result.

3. Very oblique cuts were made, passing almost parallel to the petiole and through it (figure 4). So long as the leaf did not wither, no abscission took place.

4. A slender internode was punctured by a needle, this being allowed to remain *in situ*. No result beyond the drying up of one side of the stem near the needle resulted.

Injury itself is therefore not a direct stimulus to abscission, for it is only when the physiological correspondence between the proximal and distal parts is incomplete that it intervenes.

The position of the abscission layer. In the case of internodes, whether floral or vegetative, the abscission layer lies a short distance above the base, but is not fixed strictly in any particular position. The significance of the occurrence of two superimposed layers has been pointed out above. In the floral axis it is transverse while in the vegetative it is usually oblique, often enough so as to form an angle of about 30 degrees with the axis of the stem. It begins 3 mm. or less above the axillary bud and passes downward.

When two leaves are placed directly opposite to each other, (the leaves being normally alternate) a separate abscission layer will be formed for each leaf, and will meet in the middle to form a single V-shaped one when complete, the sulcus of the V lying at right angles to the plane of the two leaves (figure 5). If, instead of being absent, there is a short internode between neighboring leaves, the abscission layers of them may still become confluent by running longitudinally to meet each other. I have observed this when the internode was as many as 7 mm. long (Figure 6).

The abscission layer is furthermore not always symmetrical with reference to the longitudinal mid-plane of the stem passing through the leaf, but may be twisted (figure 7). It is difficult to explain the varying obliquity and other departures from a plane transverse position except on the theory of displacement of

the tissues, a view which must be called into service to explain the peculiarities seen in the abscission of the cotton boll, which I have described elsewhere (l. c.).

The position of the abscission layer which removes the leaf-base and accompanying bud and which I have called lateral axial abscission, is, above the bud, identical with abscission in the oblique position, if that were taking place. This appears to be so from the fact that both oblique and lateral abscission may take place at the same time, the single layer separating into two which swerve away from each other in the middle of the stem (figure 3c). The lateral abscission layer then passes downwards and out on the same side of the stem that it entered, either below, or, it may sometimes be through, the leaf-base.

The course of the abscission layer through the tissues varies but it is not "almost as smooth as a knife cut", if I place on their phrase the meaning which Gortner and Harris intended. It may indeed appear so after dessiccation, but when examined at or soon after the completion of abscission, it is as follows:

In the floral axes, the abscission layer passes transversely through the cortex but moves distally when it reaches the vascular tissues. The disruption of the traces is a little irregular. Through the pith the layer again runs transversely, but the plane is placed further away from the base of the internode, so that the central portion of the stem stands up like a peg on the stump which is left (fig. 8).

In the vegetative internodes it is quite otherwise. Here it runs downwardly at a sharp angle through the cortex and pith toward the centre, forming at the top of the stump which is left a crater-like depression (figure 9) from which the ends of the vascular strands project upwards. Rarely the concavity does not occur in the pith, but when I have observed this to be the case, the layer passes downwards at some point. (figure 10). There results from the steep angle of the abscission layer through the cortex a very thin frill-like margin on the stump. The first evidence of actual separation becomes apparent when, because of the lifting effect of the pith, the already separated surfaces lying between the frill and the apposed cortical cells of the distal part are thereby moved apart, and so allowing the entrance of air. The total reflection of the intercellular external cell-surfaces makes a shining band indicating the abscission layer. After this the cuticle is torn.

The method of abscission. There is no special abscission tissue. The immediate cause of abscission in internodes, leaves and floral parts is the hydrolysis of the middle lamella, and no disintegration of tissues in any other sense takes place. This is equally true of all the living element of the vascular tissues. In suitable preparations, the free ends of sieve tubes and companion cells can be perfectly seen. There is no tearing or distortion except such as is due to absorption of water. The loosening of the cells is not confined to a single intercellular plane, as is shown by the fact that if a drop of water be placed on a fresh surface just after abscission, separated individual cells will float out. Increased turgor which has been supposed by Loewi to be capable of effecting separation in a mechanical way (*Ampelopsis*) does not enter in since the abscission cells and those of nearby tissues are isotonic and since there is no swelling of the tissues previous to abscission. Furthermore I have found that abscission is not hindered by a slight but evident amount of wilting. However, after the digestion of the middle lamella has proceeded in the cortex, thus releasing the pressure on the pith, the abscission surfaces may be pulled apart by the extending pith. In support of this view that turgor itself is insufficient to cause abscission, I may cite the

observation that when young willow shoots are kept in a moist chamber, abscission may commence, but may be inhibited and is then followed by a condition of oedema. The abscission cells then increase in size, become contorted, and tear apart unevenly without however producing anything like abscission. (figure 11). To see in turgor alone a means of tearing apart the abscission cells, which in such a form as Impatiens have very delicate walls, always along the plane of the middle lamella and with no single cells damaged to the extent even of a slight distortion, is in my opinion to see too much.

The course of abscission. Abscission does not begin at the same time and proceed at the same rate everywhere in the layer but first occurs above the axillary bud, and is last accomplished on the opposite side of the stems. In a stem 12 mm. in diameter, several days intervened between the beginning and end of abscission.

The position of the layer can be foreseen in stems sufficiently transiucent by a deepening of the green colour. In the thick stem just mentioned this deepening of colour enabled me to plot out the position of the abscission zone six days before any separation became evident. Less time is required by smaller stems.

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DESCRIPTION OF PLATE.

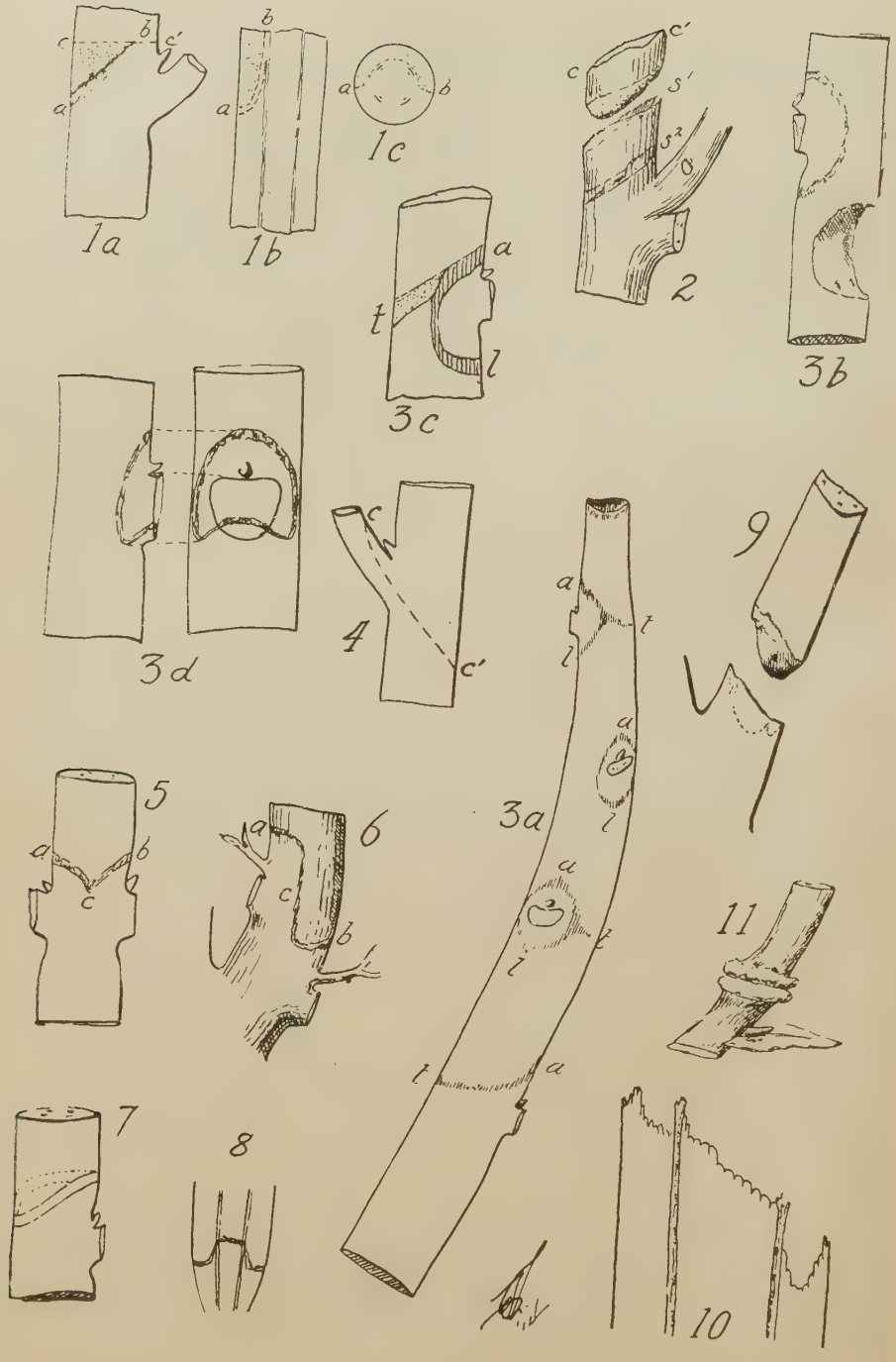
All the figures relate to Impatiens sultani except figure 11 which is Salix sp.

Fig. 1. A. Abscission layer (ab) intersecting the plane of amputation (*c*, *c'*);

B. Longitudinal and C. transverse diagram to show the portion separated by abscission.

Fig. 2. Superimposed abscission layers s1 and s2 in an internode amputated at cc'.

Fig. 3. Laternal axial abscission. A. Stem from which the leaf bases and accompanying axillary buds are being separated by lateral abscission (*al.*) in


1a
1b
1c
2
3b
3c
3d
4
3a
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some cases combined with transverse axial abscission (*at.*) B. Lateral axial abscission in two adjacent nodes. C. Diagram to show the relation of transverse and axial abscission layers. D. A lateral axial abscission layer which passed through a leaf base.

Fig. 4. Diagram of position of cut which may be made without causing abscission so long as the leaf does not wither.

Fig. 5. Two abscission layers beginning at a and b, and meeting at c, above opposite leaves.

Fig. 6. The confluence (c) of two abscission layers (*a* and *b*) when the nodes were separated about 7 mm.

Fig. 7. Diagram to show twisting of the abscission layer.

Fig. 8. The course of the abscission layer in a peduncle.

Fig. 9. The course of the abscission layer in a vegetative stem. This is the usual course.

Fig. 10. An abnormal case of the same.

Fig. 11. A young twig of willow in which abscission began but was inhibited, after which an oedema set in.

SOME USEFUL KEYS TO SOME IMPORTANT ECONOMIC INSECTS

By W. Lochhead, Macdonald College.

COCCIDAE.

The Chief Sub-Families and Genera.

Chief Sub-Families.

A. Abdominal spiracles present on each segment; males with compound eyes; adult females with white waxy lamellae—*Orthezinae.*

AA. Abdominal spiracles absent; males with simples eyes;

B. Concealed beneath a "scale", formed partly of larval exuviae, partly of secretion; abdomen ending in a "pygidium"—*Diaspinae.*

BB. Naked or covered with a waxy secretion, but not beneath a "scale"; abdominal pygidium absent.

C. Extremity of abdomen cleft; anal orifice closed above by a pair of triangular plates, anal ring fringed with setae; waxy scale not separable from the insect—*Coccinae.*

CC. Extremity of abdomen not cleft; no anal triangular plates, anal ring without setae—*Dactylopinae.*

Chief Genera of the Diaspinae.

A. Scale of female circular to oval with central, sub-central, or sub-marginal exuviae.

B. Scale of male resembling scale of female in colour and texture; only slightly elongated.

C. Pygidium with 6 groups of circumgenital gland-orifices—*Comstockiella.*

CC. Pygidium with less than 6 groups of gland orifices.

D. Chitinous processes much elongated—*Chrysomphalus.*
DD. Chitinous processes smaller and shorter or wanting — *Aspidiotus.*

BB. Scale of male white, delicate and carinated.
C. Dorsal spinnerets irregular; exuvia usually sub-central—*Diaspis.*
CC. Dorsal spinnerets in distinct bands; exuvia terminal in 2nd stage female and marginal in adult—*Aulacaspis.*

AA. Scale of female elongated with exuvia at one extremity.
B. Scale of male similar to scale of female, but smaller; five groups of gland-orifices—*Lepidosaphes.*
BB. Scale of male white, small with parallel sides and carinated. — *Chionaspis.*

Chief Genera of the Coccinae.

A. Naked or covered only by a filmy secretion.
B. Flat or slightly convex; dermis alveolate—*Caccus.*
BB. Very convex, usually hemispherical; hard when mature.
C. Dermis with coarse polygonal pitted areas—*Saissetia.*
CC. Dermis microscopically tesselate, or appearing smooth. — *Eulecanium.*

AA. With a strong cottony secretion; secreting an ovisac; body more or less chitinous without dorsal patches of secretion—*Pulvinaria.*

Chief Genera of the Dactylopinae.

A. Female globular or reniform in a hard shell; larva fringed with spines — *Kermes.*
AA. Female not as above.
B. Adult surrounded by secretion but dorsally naked—*Gossyparia.*
BB. Adult forming a cottony sac; caudal lobe long—*Eriococcus.*
AAA. Female with soft powdery oval unarmored body—*Pseudococcus.*

APHIDIDAE.

Sub-Families and Chief Genera.

Chief Sub-Families.

A. Front wings with three discoidal veins; antennae generally 6 or 7-jointed.
B. Third discoidal vein of front wings twice forked—*Aphidinae.*
BB. Third discoidal vein of front wings once forked or simple—*Pemphiginae.*
AA. Front wings with two discoidal veins; antennae never more than 5-jointed—*Chermesinae.*

Chief Genera of the Aphidinae (tentative).

A. Antennae as long as the body.
B. Honey tubes long; antennae not hairy.
C. Frontal tubercles of antennae distinct and gibbous on inner side. body covered with capitate hairs—*Myzus.*
CC. Frontal tubercles approximate—*Nectarophora.*

CCC. Frontal tubercles distinct—*Phorodon.*
BB. Honey tubes short, beak short, antennae smooth—*Callipterus.*
AA. Antennae shorter than the body.
B. Honey tubes long; antennae not hairy—*Aphis.*
BB. Honey tubes sort; antennae hairy.
C. Beak long—*Lachnus.*
CC. Beak short.
D. Body tuberculate with long and slender hairs—*Chaitophorus.*
DD. Body not hairy—*Melanoxanthus.*

Chief Genera of the Pemphiginae.
A. Third discoidal vein simple.
B. Hind wings with two discoidal veins—*Pemphigus.*
BB. Hind wings with but one discoidal vein.
C. Antennae 6-jointed—*Tetraneura.*
CC. Antennae 5-jointed—*Hormaphis.*
AA. Third discoidal vein forked.
B. Hind wings with two discoidal veins—*Schizoneura.*
BB. Hind wings with one discoidal vein—*Colopha.*

Chief Genera of the Chermesinae.
A. Antennae 5-jointed—*Chermes.*
AA. Antennae 3-joined—*Phylloxera.*

CARABIDAE.

(*Ground-beetles.*).

(After Leconte and Horn).

Common Genera.
A. Middle coxal cavities entirely closed by the sterna.
B. Head with two punctures above the eye, each bearing a single bristly hair.
C. Margin of elytra interrupted at posterior end and with a distinct internal fold; three basal joints of antennae glabrous.
D. Last joint of palpie as long as or longer than the next to the last and cylindrical—*Pterostichus.*
DD. Last joint of palpi shorter than the next to the last—*Amara.*
CC. Margin of elytra not interrupted posteriorly and without an internal fold.
D. Penultimate joint of labial palpi with but two bristly hairs; elytra truncate at tip; front tibiae slender; tibial spurs short, head constricted behind the eyes—*Lebia.*
DD. Penultimate joint of labial palpi with a number of bristly hairs in front and always longer than last joint; first antennal joint elongate; head olongate oval, prolonged behind the eyes—*Galerita.*

BB. Head with but one bristle-bearing puncture above the eye.
C. Elytra truncate at apex; mandibles with a bristle-bearing puncture in outer groove; hind coxae often separated—*Brachinus* (Bombardier beetle).
CC. Elytra always entire; mandibles without a bristle-bearing puncture; hind coxae contiguous.
D. Antennae with only two basal joints glabrous; black, front tarsi of male dilated and with two rows of small scales beneath; first joint of hind tarsus not longer than the two following—*Harpalus*.
AA. Middle coxal cavities not entirely closed by the sterna.
B. Hind coxae not separated; labrum not forked; third joint of antennae cylindrical—*Carabus*.
BB. As in B, but third joint of antennae compressed—*Calosoma*.

ELATERIDAE.

Common Genera.
A. Hind coxal plates suddenly dilated about the middle, the outer part much narrower than the inner.
B. Prosternum very broad, sutures straight, side pieces of mesothorax reaching the middle coxae—*Cryptohypnus*.
BB. Prosternum of moderate width; sutures double and not excavated in front; third joint of antennae longer than second—*Drasterius*.
AA. Hind coxal plates gradually dilated on the inner side.
B. Clypeus or front convex and truncate, its edge higher than the labrum, mouth inferior and applied to the prosternum in repose. Side margins of thorax bent downward in front—*Agriotes*.
BB. Clypeus of front flattened; mouth horizontal or anterior.
C. Front margined; tarsal claws with comb-like teeth—*Melanotus*.
CC. Front not margined.
D. Tarsi simple, filiform—*Corymbites*.
DD. Tarsi with the second and third joints lobed beneath — *Asaphes*.

CHRYSOMELIDAE.

(*Leaf-beetles*).

(Adapted from Leconte and Horn).

Common Genera.
A. Head produced; thorax narrower than elytra; mandibles simple, pointed.
B. Thorax cylindrical, not constricted.—*Crioceris*.
BB. Thorax constricted.—*Lema*.
AA. Head inserted in the thorax to the eyes; thorax as broad as the elytra; mandibles with several teeth.
B. Last dorsal segment of abdomen not exposed.
C. Antennae widely separated at base.

D. Front coxae transverse.—*Leptinotarsa.*
DD. Front coxae rounded; 3rd tarsal joint bi-lobed.—*Fidia.*
CC. Antennae rather close at base; front coxae conical.
D. High thighs slender and front coxal cavities open behind.
E. All the tibiae without terminal spurs.—*Galerucella.*
EE. Middle and hind tibiae with terminal spurs.—*Diabrotica.*
DD. Hind thighs thickened.
E. Front coxal cavities open behind.
F. Thorax with a feeble transverse impression on basal half; hind tibiae with a short terminal spur—*Haltica.*
FF. Thorax without transverse impression near base; elytra usually with a yellow stripe or spots—*Phyllotreta.*
EE. Front coxal cavities closed behind.
F. Thorax with a distinct transverse impression near base; elytra with rows of stiff hairs; form short, ovate—*Epitrix.*

MUSCIDAE.

Common Genera.

A. Proboscis long, slender, directed forward; arista pectinate.
B. Palpi nearly as long as the proboscis—*Haematobia.*
BB. Palpi much shorter than proboscis—*Stomoxys.*
AA. Proboscis not elongate, labella fleshy and not adapted for sucking.
B. Arista plumose; hypopleurae with a vertical row of bristles; eyes bare.
C. Thorax and abdomen with depressed hairs among the bristles — *Pollenia.*
CC. Thorax and abdomen without such hairs; mesonotum distinctly striped; bright metallic—*Chrysomyia.*
BB. Arista plumose; hypopleurae without a row or tuft of bristles.
C. Last section of 4th vein has a rounded angle—*Musca.*
CC. Last section of 4th vein curved forward, often slightly, beyond its middle or at the tip, the cell broadly open; the first longitudinal vein ending beyond the middle of the wing—*Muscina.*
BBB. Arista plumose; hypopleurae and eyes as in B.
C. Mesonotum flattened behind the transverse suture; posterior dorsocentral and acrostical bristles inconstant and unequally developed—*Phormia.*
CC. Mesonotum not flattened behind the transverse suture; posterior dorsocentral and acrostical bristles well developed and constant.
D. Cheeks hairy; 3rd longitudinal vein spinulose at base only—*Calliphora.*
DD. Cheeks bare; 3rd longitudinal vein spinulose—*Lucilia.*

INSECTS INJURIOUS TO STORED GRAIN.

(After Girault, Bull. 156, Illionois Ag. Exp. St.)

A. *Moths or millers.*

B. Caterpillar small, whitish, living in grains of corn or wheat, pupating within the grain, and emerging through a round hole covered with silk at or near the tip of the kernel. Adult moths grayish clay-yellow, small — *Angoumois Grain Moth* (Sitotroga cerealella).

BB. Caterpillars, spinning much silk, usually forming a silken tube to which they retire; this tube covered with food particles. Living in flour, meal, chaff, sometimes among grain, or in food substances. Full-grown caterpillars make a cocoon.

C. Caterpillar free-living usually not concealed within a silken tube, olive-green to pinkish, infesting grain or meal, webbing particles together, covering bags of grain with a web of silk and generally scattering silk in all directions. The moth is brown and gray Cocoon elliptical, slender, fragile and of clear silk—*Indian Meal Moth* (Plodia interpunctella).

CC. Caterpillars living in densely woven silken cases covered with particles of the food substance. Common in flour or chaff in corners.

D. A yellowish white to pinkish caterpillar in flour, webbing it together and forming a cocoon covered with particles of flour. Moth dark grayish — *Mediterranean Flour Moth* (Ephestia kuehniella).

DD. A soiled grayish caterpillar, darker at each end, living in chaff or other vegetable debris in dark damp places, securely webbing the food substance together, so that it becomes matted; larval case and cocoon completely hidden, covered with the food substance. Adults very beautiful and delicately coloured moths—*Meal Snout-Moth* (Pyralis farinalis).

AA. *Beetles or weevils.*

B. Small insects living in kernels of grain, or among grain and other stored products.

C. A very small, fat, humped-up grub, in kernels of wheat or corn; yellowish-white, legless, very humpedébacked and wrinkled, unable to crawl; inconspicuous and yellowish brown; pupa within the kernel. Adult smaller than a grain of wheat, with a snout, and elbowed feelers attached to the snout.

D. Adult beetle chestnut-brown, without spots on its upper wings. Slightly larger than the next, more common in the North — *Granary or Black Weevil* (Calandria granaria).

DD. Adult beetle somewhat duller brown than the preceding with four reddish spots, one on each outer corner of the upper wing. A southern species—*Rice or Spotted Weevil* (Calandra oxyzae).

CC. Small, more or less slender, somewhat flattened grubs, with distinct head and thoracic legs, crawling about in the debris of various grains or their products, or in vegetable foodstuffs. Adults flattened, longer than wide, the head not prolonged into a snout. They occur with the grubs, actively feeding.

D. Grub uniform in colour, whitish, about one-fourth inch long, slender, its head narrower than the first body segment; pupa with the thorax not toothed laterally, but with most of the abdominal segments bearing a tooth-like lobe, acute at each outer corner and toothed along its sides. Adult beetle active, smooth, elliptical, and reddish brown— *Confused Flour Beetle* (Tribolium confusum).

DD. Grub whitish, with a rectangular yellowish area on each segment above, only the margin whitish as seen from above; head broader than first body segment. Pupa bears along each side of the thorax and abdomen a series of stout lobe-like teeth, which are cylindrical-rectangular and blunt. Adult beetle smaller than in the preceding species, colour dark chocolate-brown, sides of the thorax saw-toothed—*Saw-toothed Grain beetle* (Silvanus surinamensis).

B. Large insects, concealed in the bottoms of bins, corners, and the like, feeding upon flour, meal or bran. Adults large black beetles; the larvae, large, cylindrical, wormlike creatures, resembling wireworms.

C. Adult not quite black in colour, shining, its third antennal joint not quite twice as long as the second; larva light yellowish, shining— *Yellow Meal-worm beetle* (Tenebrio molitor).

CC. Adult black and without luster, its third antennal joint thrice as long as the second; larva very dark, shining—*Dark Meal-worm beetle* (Tenebrio obscurus).

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